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The Brabazon

EARLY in the career of the Convair B-36, some three years ago, *Flight* posed the question "milestone or millstone?" Here was the world's largest landplane—a bomber of Brabazonic proportions—on the production line before operation in its prescribed role was known to be feasible. Little wonder that dogma and rumour, playing upon an astronomical expenditure and the obscure commercial and military background of the aircraft, should precipitate a public enquiry.

From the ensuing skirmish the great bomber emerged vindicated if not triumphant. That the Brabazon—the subject of a well-merited special supplement in this issue—has not yet achieved a similarly reassuring status in the public estimation is regrettable, and the fact must be faced that years will elapse before those who have cast doubt and ridicule on the whole project can be adequately answered. Indeed, the most meritorious performance of the piston-engined Mk. I prototype is unlikely to be accepted as a guarantee for the Mk. II.

But the Brabazon has left the ground, though many people were prepared to lay odds that she would never accomplish even this, and in some 4½ hours' flying has behaved well and proved remarkably vibration-free. After the last of her preliminary flights she withdrew for the work not surprisingly required on such an elaborate mass of mechanism, and resumption of flight-tests is imminent.

The Bristol Company has shown no inclination to dilate upon the results of the early tests (their technical staff, in all conscience, are sufficiently occupied without being badgered for the whys and wherefores of their findings), but when testing is fairly under way both they, as makers, and the Ministry of Supply, as contractors, can be counted upon to keep the public fully apprised of Brabazon progress.

We ourselves look forward to continuing the chronicle of what, after all, is an historic venture, and one which cannot bring discredit on Great Britain provided vacillation is not allowed to frustrate its fulfilment.

Tradition to Maintain

THE Air Exercise which took place last week-end had much to teach the interested observer; obviously, the full value of the results cannot be assessed for some weeks yet but, nevertheless, there were many aspects of the operation which, viewed as a whole, provided a clear picture of things as they are in the R.A.F.

That such exercises are of immense value in testing the efficiency of the planning, directing and administrative sections of the Commands engaged goes without saying. Further, the benefit of giving the ground and aircrews some invigorating breath of even synthetic operational air is unquestionable; and this applies equally to the filtering, plotting and controlling staffs, to the A.A. gunners and to the catering sections.

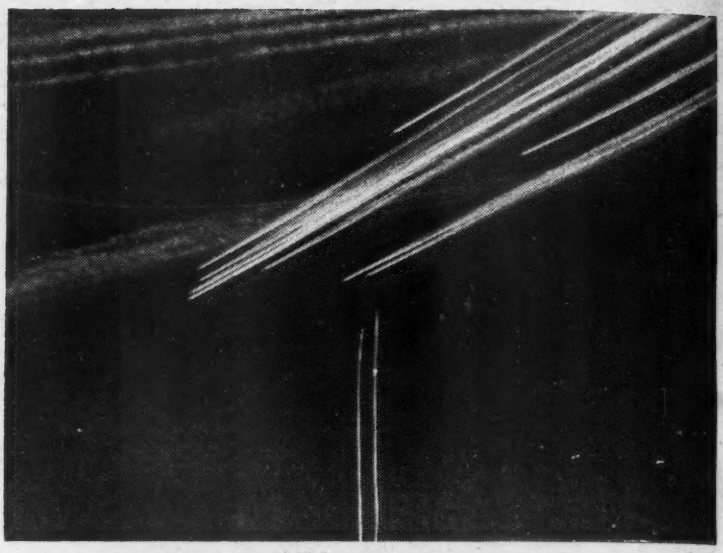
That Fighter Command, improving week by week, is already in a state of high efficiency is hearteningly evident, and the radar backing, without which modern defensive fighting would be impossible, is capable of equal efficiency. The fighting form of the Meteors and Vampires is also extremely high, and in this regard the harrying of Harvards and Prentices at 120 knots and at very low level by aircraft which more usually fight above 30,000ft is nothing less than wonderful.

The companion aspect of the picture as provided by Bomber Command is, however, less encouraging. In operational efficiency the Command has made no appreciable advance upon the standard set during the war. This is due to a great extent to the lack of all-round improvement in equipment (the country's policy in regard to jet bombers is well known), and partly to the almost complete lack of experienced aircrews remaining after the tremendous reduction in the strength of the Command.

Fortunately, a large number of those who had experience of action in wartime and are still flying are now in Flying Training Command, where they pass on the lessons and lore they learned at so high a cost. Naturally, as the months go by, the number of war-experienced aircrew who continue flying must grow less, and it is therefore all the more important that every scrap of knowledge, and the operational spirit and tradition which are so essential to success, should be handed on now.

EXERCISE "BULLDOG"

The Turn of the Bombers : Trainers Assist : Western Union Air Forces Aid the Defences



Meteors and B-50s, at grips late on Sunday afternoon, afforded a magnificent view of a modern air engagement.
"Flight" photograph.

WHEN, in June, we gave a narrative account of Exercise *Foil*, it was stated that the official intention was to hold exercises alternately with a fighter bias and a bomber bias. *Foil* was designed primarily as a fighter exercise and was thus basically defensive. The complementary offensive bomber exercise—under the name *Bulldog*—took place over last week-end. As before, in addition to Regular units, squadrons of the R.Aux.A.F. were engaged, together with squadrons of the French, Dutch and Belgian Air Forces, these being under the overall command of the A.O.C.-in-C., Fighter Command, Air Marshal Sir Basil Embrey. In opposition, Bomber Command were aided by B-50s and B-29s of the U.S.A.F. Third Air Division under Major-General Leon W. Johnson, and by Mosquitoes of B.A.F.O., whilst the overall direction of the exercise was the responsibility of Air Marshal Sir Aubrey Ellwood, A.O.C.-in-C., Bomber Command

At H.Q. Bomber Command on the eve of *Bulldog* are (left to right) Air Marshal Sir Aubrey Ellwood, (Bomber Command), Air Marshal Sir Basil Embrey (Fighter Command), General Sir G. I. Thomas (Anti-Aircraft Command) and Major-General Leon W. Johnson (3rd Air Division, U.S.A.F.).

Mr. Arthur Henderson, Secretary of State for Air (right) and Major-General Johnson discuss an operation—on which the Air Minister flew in a B-50—with the commander of the aircraft, Lt. Alan B. Thomas. The General flew as second pilot.

It was extremely unfortunate that, in the event, bad weather in the form of low stratus extending over almost the whole country prevented the exercise being started, as intended, on Friday evening—the more so in that both air- and ground-crews were keyed up to "first night" pitch and then had to stand down. The "duff" weather continued until Saturday morning was well advanced and, in fact, the first action of the exercise did not take place until 1300 hours, when individual attacks were made from between 30,000 and 40,000ft by Meteors simulating jet bombers; the targets, which were raided simultaneously, were London, Leicester, Reading, Swindon, Oxford, Peterborough and Gloucester.

In order to provide a wider ambit of experience for aircrew under training (and a refresher course for instructors) Wellingtons, Ansons, Harvards and Prentices of Flying Training Command were given attacking rôles to play, and in the early stages of the exercise, at least, Fighter Command airfields were frequently caught on the hop by their low-level attacks.

Attacks were widespread from as far north as Rosyth and Glasgow to the southern targets at Portsmouth and Yeovil, while, in the evening dusk, B.A.F.O. Mosquitoes from Celle flew in to attack south-east coastal targets at low level.

Bad weather again had its effects on night bombing activity, and the size of the main force of Lancasters and Lincolns attacking Southampton had to be curtailed—although, fortunately, fair weather favoured the actual

attack, which was made visually from 10,000ft. Night attacks were also made by B-50s, which claimed successful bombing of their target in the Enfield district from 35,000ft without fighter opposition; understandable but nevertheless disquieting.

Sunday started with low-level attacks by B.A.F.O. Mosquitoes on south-eastern airfields, and in the early afternoon a sizeable force of Meteor 4s acting as jet bombers made widespread attacks at high altitude; both Meteor and Vampire fighters effected some successful interceptions at heights up to 40,000ft. A force of B-29s attacked a target near Oxford at 1430 hours (the actual raid is referred to below), and the same target was again raided by a force of B-50s at 1700 hours. Both sorties were intercepted more than once, on one occasion by R.A.F. and Western Union Meteor squadrons operating south-east of London. Mosquitoes made a high-altitude bombing attack on Birmingham during the afternoon, whilst Ansons attacked the docks at Newport.

The main target for the Sunday night operations was at Stoke-on-Trent, a large force of Lincolns, Lancasters and marker Mosquitoes making their attacks at 2200 hours. Diversionary raids were made by B.A.F.O. Mosquitoes and Flying Training Command aircraft, the latter raiding Swindon at 2140. Ansons simulated mine-laying in the Portsmouth Approaches, and night fighters, including a Belgian squadron operating from an airfield in Kent, played a considerable part in the operation.

As we go to press the closing phases of Exercise *Bulldog* are still in being, and further comment must therefore be held over for our next issue. Some personal impressions follow.

"*Flight*" photograph.

Multilateral control: F/L. V. Young, R.A.F., and Lt. Detournay of the Belgian Air Force share controlling duties at Thorney Island. Lt. Klinkhamer, from Holland, was also controlling.

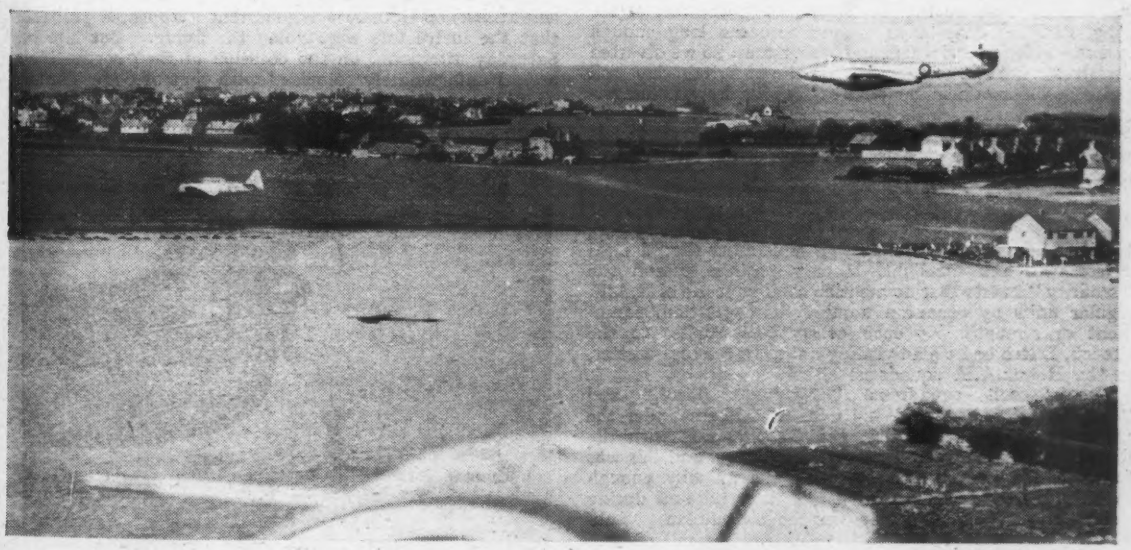
HEAD-ON IN A METEOR

AFTER Sunday lunch (writes a member of the staff of *Flight*) we flew in a Meteor 7, which, with twelve Mk. 4s, was vectored on to ten B-29s approaching from Dunkirk. From 25,000ft we spotted them forty miles off and having with some difficulty determined their course, we found their level at 22,000ft before going at them head-on. Closing at supersonic speed it became suddenly obvious that there was no future in holding course. Our Meteor bucked violently, and, by some miracle still having our eyes open, we saw that we had passed under the bombers.

Plt. III Murphy, who now enquired politely after our health, does not bear his name for nothing. Seeing that S/L. Woods and the rest of the wing were assiduously plying their trade, he piled in again (the metaphor is apt, as the Meteor was sometimes touching compressibility) for some assorted attacks. On the purely tactical aspects of these we are not free to dilate, but potential B-29 operators will profit little from the knowledge that on one pass Murphy got in a sustained burst of 16 mm film from 500-150 yd and claimed a kill on the strength of it.

One recollects reading "U.S.A.F." in very large, red letters on a soot-black wing, noting blue-triangle and blue-and-white-diagonal markings (characteristic of tankers of the 43rd Bomb Group, U.S.A.F.), and being sharply cuffed by slipstreams in breaking away. Four miles below—marvellously patterned and gilded—cloud, sea and land wheeled unceasingly, though once, as we greyed-out, it seemed as though a dirty eraser had been drawn over the picture.

Somewhere near Ashford we were called off and, hoping to find some "rats" nibbling at base (our pilot had bagged ten Harvards the day before—six in one sortie—and had



"*Flight*" photograph.

From one of a formation of six Harvards the camera records an exciting moment as Meteors, from the airfield under attack, pounce on the whining, weaving trainers. One Meteor pilot who, as told above, later flew a *Flight* representative, claimed all six.

"Flight" photograph.

(Top left): Inspecting Lt. St. Macary's Vampire after its hood was jettisoned. (Top right): Wing-tip debriefing—F/L. Flowerdew of the R.F.A. delegation in France, Capt. Godde, French intelligence officer, and Capt. Lemaire, D.F.C., who led the combined French squadrons. (Bottom left): Belgian pilots beneath the flag of No. 349 Squadron watch a wing scramble. (Bottom right): Gen. Giebel, Netherlands Chief of Air Staff, talking to one of his pilots.

EXERCISE "BULLDOG" . . .

acquired quite a taste for them), we dived for home at 600 m.p.h. But we had no luck, though the rest of the wing, carrying drop-tanks, stayed airborne long enough to settle with some Hornets and Mosquitoes. So we diverted ourselves with an eight-point Battle-of-Britain-day roll and other Meteoric manœuvres before Murphy, still hungering for Harvards, set us back on the runway.

We claimed one B-29 destroyed and two damaged; but as the wing claimed nine destroyed out of the force of ten, this seemed a trifle academic.

FOREIGN CONTINGENTS

IT is inevitable that the foreign squadrons should steal some of the limelight, if only for the reason the "security" insists that no mention shall be made of R.A.F. regular units by squadron number, home station, equipment or strength. No such censor ban applies to the French, Dutch or Belgian visiting units, or, for that matter, to the R.Aux.A.F. squadrons either.

The French squadrons "Cigogne" (Stork) and "Alsace" of the Dijon Wing were at Odiham under the command of Capt. Lemaire, D.F.C., who was with the R.A.F. during the war. They fly Vampire 5s, and this was fortunate for Lt. St. Macary, who was unlucky enough to have his hood jettison itself just after take-off during a scramble. The hood passed over the low tailplane. Subsequent examination showed that the release wire had been hitched over a couple of worm clips, to facilitate the removal of ammunition tanks; this left the release mechanism at top-dead-centre, so that the vibration during take-off was sufficient to complete the action. A spare was forthcoming immediately and the Vampire was serviceable again in a matter of minutes.

The Harvards of Training Command put in some excellent attacks on Odiham—so good that it appeared probable that the instructors were doing the flying. But late on Saturday afternoon, on the occasion of their sortie, their arrival unfortunately coincided with that of S/L. Timmis and his squadron—No. 605 (County of Warwick) Squad-

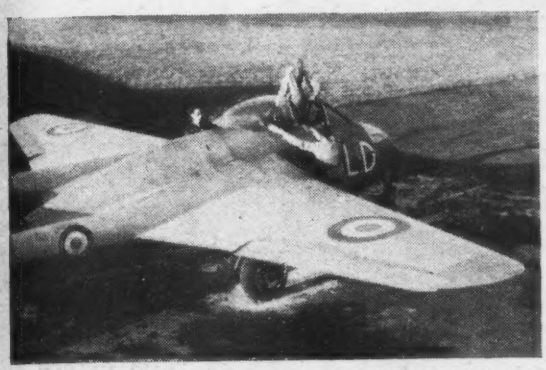
"Flight" photograph.

Unarmed B-29 tankers of the U.S. 43rd Group, one of which is shown, supplemented the B-50s on high-altitude daylight raids.

EXERCISE "BULLDOG" . . .

ron from Honily. The Auxiliary boys were "scrambled" in the air and for a while the southern side of the airfield presented a confused picture as the Vampires chased the Harvards at tree-top level.

It is frequently remarked that air exercises do not give a true picture because there are no bullets flying. But nobody could watch a wing scramble of 27 Meteors—all away in less than six minutes—such as occurred at Thorney Island on Sunday, with three nations, Holland, Belgium and Britain taking part, without being intensely moved. The noise, the complication, the perfection of the man-made machines and the discipline and the skill of the pilots that fly them—all go to quicken the pulse of the informed onlooker. And whose heart did not beat faster when he beheld that wondrous contrail picture presented to the south of England later that same autumn afternoon, when



"Flight" photograph.

A pilot of No. 605 R. Aux. A.F. Squadron climbs into his Vampire to be at readiness.

the jet fighters got among the B.50s at about 27,000ft?

The Dutch squadrons at Thorney Island were those which came over for *Foil* earlier in the year, and they were commanded as before by Maj. Flinterman.

The Belgians were here for the first time since the war, and this was also the first time they have taken part in Western Union air exercises, either in England or on the Continent. Major A. Van de Velde was in command and the contingent was drawn from Nos. 350 and 349 squadrons, which became famous as part of the R.A.F. during the war. About a third of the pilots served with the

"Flight" photograph

A Mosquito of Bomber Command's marker force is loaded.

"Flight" photograph

The crews of Mosquito night fighters are briefed at a Kentish base by F/L. H. V. Thornley.

R.A.F. at that time and the remainder have all been trained in this country. They have had their Gloster Meteor 4s for some five months now and are loud in their praise. Like the Auxiliary squadrons, each unit is to have a couple of two-seat Meteor 7s for training.

WITH THE R.O.C.

"THIS fine Corps is an integral part of the air-defence system of this country, and we are very much dependent on them." Thus spoke the C.-in-C., Fighter Command, of the Royal Observer Corps.

Watching one phase of *Bulldog* on the plotting-table of an R.O.C. Group to the N.W. of London, we realized the truth of his words. Here was an ops room like that of a fighter sector: the same intent huddle of uniformed, headphoned men and women round the big table under the hard bright fluorescent lighting; the same gallery of officers and specialists; the familiar tabbed maps and coloured signal-lights.

What happens, briefly, is that approaching tracks are first indicated (raid number, height, number and type of aircraft) on a "long-range" map of neighbouring areas. As they enter the group's own area and the reports begin to come in from the posts, they are shown on the big centre table by the plotters, each of whom is telephonically linked to three posts. The tracks are then plotted across the table, the changing picture of which is passed continuously by a "teller" to the R.A.F. ops. rooms concerned. Civil Defence representatives likewise initiate any necessary alerts on the information shown.

Going to the other end of the wire, so to speak, *Flight* also visited one of the posts. Spotting is either by sound (the human ear unaided) or, preferably, visually: a simple instrument somewhat resembling a sextant, sighted on the aircraft, gives a reading of its height and, simultaneously, an approximation of its position on the gridded plate showing the post's operational radius; it is this information which is fed to the Group Centre.

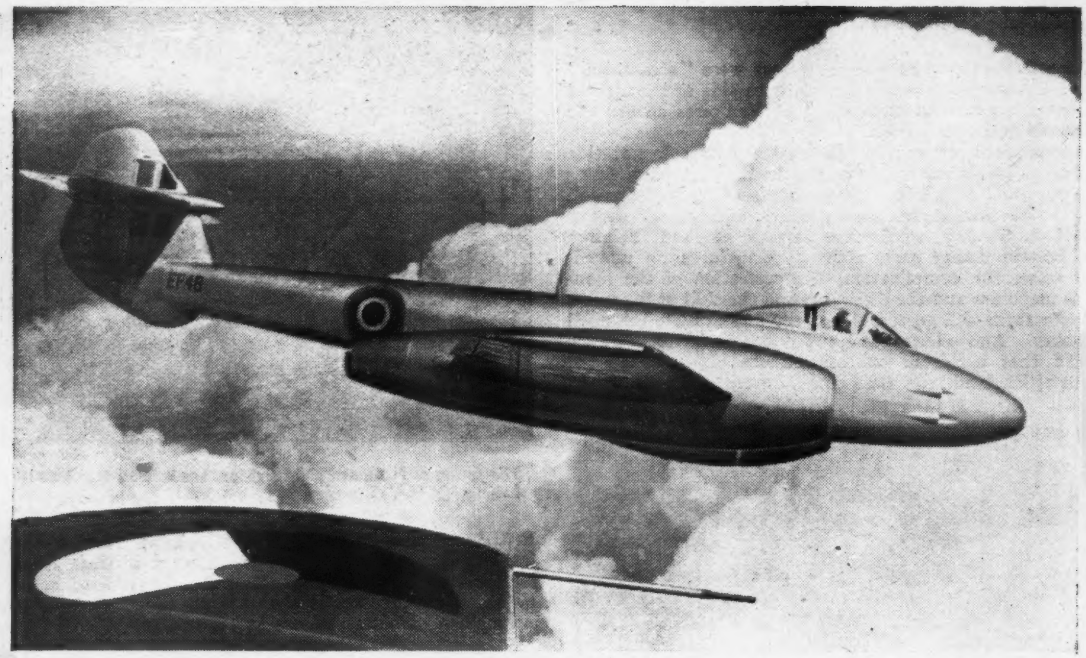
On this occasion *Bulldog* offered us nothing more hostile than Dakotas and Austers going about their lawful occasions; but all, as orders demanded, were dutifully reported.

The R.O.C., incidentally, badly needs recruits of both sexes; and enquiry will show that it is no mere spotters' club, but a real Service that can offer a vitally interesting and useful spare-time occupation.

AGGRESSION IN A HARVARD

FOR action during the first two days of the exercise one could not have done better than join a unit of Training Command operating with the bomber forces and located at

(Continued on page 406)



AFFINITY: The roundel of the Royal Netherlands Air Force visible on the wing of the Meteor 7 from which was secured this splendid study of a Meteor 4—bearing Belgian Air Force markings. Fighter squadrons of three Western Union Nations—France, Holland and Belgium—took part in Exercise *Bulldog*, described in this issue.

HERE and THERE

Theseus Progress

THE Bristol Aeroplane Company has announced that the Theseus turboprop, of the type to be used in the Handley Page Hermes V, has successfully completed the third 150-hr type test. In order to simulate actual operating conditions the test was made with a 150 h.p. accessory gear box driven from the rear of the engine.

The low maintenance requirements of turboprops were again demonstrated in this test, for no servicing other than inspection and cleaning of the oil filter was carried out during the whole 150 hours. Maximum static power has now been raised from the initial 1,950 to 2,450 b.h.p., subject to A.R.B. approval.

Orenda Experiment

NORTH AMERICAN F-86 Sabre fighters built under licence by Canadair, Ltd., may eventually be powered by a Canadian turbojet—the Avro Canada Orenda. A Dominion report says that an Orenda is now being prepared for installation in an F-86, and that ground and flight tests will be undertaken by the North American Company at Los Angeles.

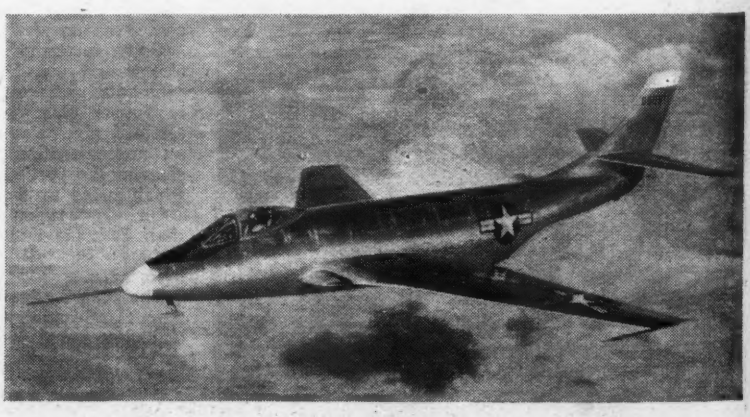
Vampires Abroad

NO. 32 Squadron Vampires arrived in Turkey on September 24th, and on the following day began their programme of demonstration with flights over Istanbul and the Bosphorus, watched by President Inönü. The visit, which was due to end yesterday, is described as a great success.

Less fortunate were pilots of No. 73 Squadron, Malta, who made forced landings on the way to Milan last Friday for a seven-day goodwill tour of Italy. Milan airport, it is reported, was covered by fog at the time. One pilot is said to have baled out, breaking a leg, while three of the four Vampires which made emergency landings at Brescia were damaged. Four replacement Vampires arrived at Milan the following day; of these one is stated to have had brake trouble and to have been damaged on landing, but without injury to the pilot.

Fit for a King

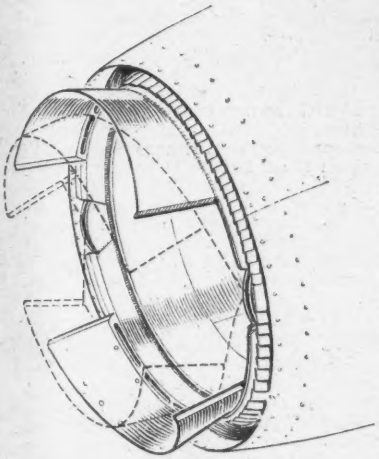
IT is reported that King Feisal of Iraq intends to buy a modern passenger aircraft for his personal staff use, and that His Majesty showed great interest in the turboprop-powered Apollo at the recent Farnborough display. H.R.H. the Prince Regent of Iraq last week visited the Armstrong Whitworth factory near Coventry and made a short flight in the Apollo, accompanied by Lt.-Col. J. Mohammed and Lt. A. A. Razzak (King Feisal's pilots), and Col. Said Ibrahim.



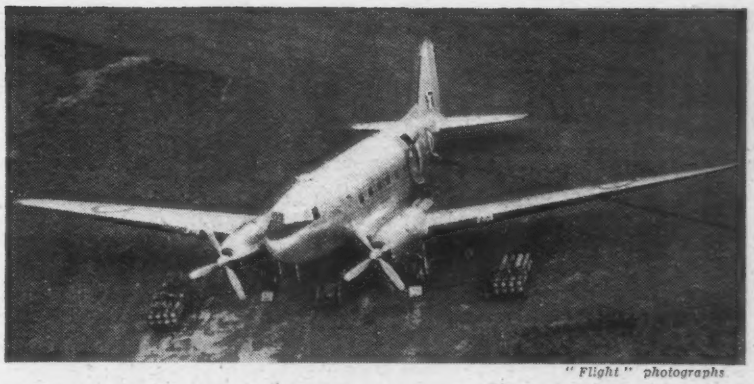
TRIM SHIP: A new view of the McDonnell XF-88 penetration fighter—reported to be capable of 700 m.p.h. at sea level—emphasizes its neat, promising lines. It will be noted that wing and tail surfaces are swept, and that the two Westinghouse J-34 axial turbojets, which eject below the aft fuselage, have wing-root intakes.

700 m.p.h. Sabre

A NORTH American F-86 Sabre jet fighter of the U.S.A.F. recently attained a speed of 700 m.p.h. after a dive—30 m.p.h. faster than the present world's speed record, established a year ago by an aircraft of the same type. The pilot on the latest flight was Lt.-Col. Marion Carl, of the U.S. Marine Corps, who held the previous speed record—set up in 1947 with a speed of 650 m.p.h. in the Douglas Skystreak Naval research aircraft. It is rumoured that both the Sabre and the McDonnell XF-88 Voodoo—a twin-jet, raked-wing long-range fighter for the U.S.A.F.—may be flown in forthcoming attempts to raise the record to 700 m.p.h.



HOT SPOT: Detail of the variable-area nozzle of the experimental reheat Meteor—a Rolls-Royce development. Such a device is essential if the full benefits of reheat are to be realized. Reference to earlier National Gas Turbine Establishment designs was made on p. 365 of *Flight*, September 15th.



"Flight" photographs

MAMBA DAK: With two Mamba 3 turboprops fitted in place of the normal Pratt and Whitney Twin Wasps, an otherwise standard Dakota not only gives useful experience with the power units, but also offers a practicable method of modernizing the D.C.-3. This Armstrong-Siddeley conversion was fully described in last week's issue.

Air-Arm of the Law

ACCORDING to a Berlin newspaper, the People's Police Force—a semi-military organization in the Russian Zone of Germany—is to receive a total of 1,200 aircraft by next spring. The report, which is without confirmation, states that the force will have fighter, bomber and reconnaissance groups.

Refuelling Hazard

PILOTS have been warned by the Ministry of Civil Aviation (in *Notice to Airmen, No. 139*) that B-50 Stratobombers and B-29 Superfortresses of the U.S.A.F. will practise refuelling in flight on a line between Great Yarmouth and Heligoland until December 1st next. They are instructed not to fly within 1,500ft horizontally, or 1,000ft vertically, of aircraft engaged in this operation.

It will be remembered that the 43rd Bomb Group, which arrived in England recently, is equipped with a number of B-29s modified to act as tankers for its B-50s. One of these aircraft flew round the world non-stop last March.

FORTY YEARS BACK

"The official record of the Aero Club states that M. Santos Dumont rose from the ground after travelling 70 metres in 6½ seconds, thus beating the record of Mr. Glenn Curtiss, who got up in 80 metres. The "Demoiselle" actually rose when only 40 metres had been covered, but it touched earth again, and 70 metres were traversed before the little flyer got clear away."—*From "Flight" of September 25th, 1909.*

NEWS IN BRIEF

IN recognition of his film and newspaper coverage of the Pacific air war, Mr. William Courtenay has been made an honorary member of the Fifth U.S.A.F.

* * *

Construction of the 970-acre, £37,500,000 Esso refinery at Fawley, Southampton, work on which started three months ago, is already a month ahead of schedule.

* * *

Mr. R. C. Christoforides, who founded the Chrislea Aircraft Co., Ltd., in 1936, has recently resigned from the Board and is succeeded by Mr. E. A. Doran. Production policy for the Super Ace aircraft, states the firm, will not be affected. Mr. Christoforides' friends can get in touch with him at Coombe House, Salcombe Hill, Sidmouth, Devon.

* * *

Mr. J. D. Pearson, Wh.Sch., B.Sc. Eng. (Lon.), A.M.I.Mech.E., and Mr. W. A. Robotham, M.I.Mech.E., have been appointed directors of Rolls-Royce, Ltd. Mr. Pearson, who has been closely associated with R.-R. aircraft engine design and production since 1933, held senior posts in the shadow factory at Hillingdon, Glasgow, during the war, and later laid the foundations of the company's Montreal business. Latterly he has been deputy general manager of the Aero Division at Derby. Mr. Robotham's interests lie mainly in the car sphere.

Mr. J. D. Pearson

SEAT OF LEARNING: Many R.A.F. pilots will receive their first experience of jet flight in the two-seat Meteor 7, now going into service. That the instructor's seat—from which this new view was taken—is also an excellent position for air-to-air photography is proved by the picture of the Belgian Meteor 4 at the top of the page opposite.

EXERCISE "BULLDOG" (continued from p. 403)

Feltwell. From there a large number of low-level sorties were flown against fighter airfields with considerable success. *Flight's* representative flew on the second raid to be made by Harvards against an airfield in S.E. England. Six aircraft were dispatched and the plan was to fly in pairs—or sections of two—in loose vic formation, keeping low enough to escape radar detection.

Approaching the Colchester area (writes our observer) we came down to tree-top height and saw no sign of defending fighters. Over the Isle of Sheppey a quick turn to starboard along the coast gave the first indication of our probable target to observers, and we caught a glimpse of the aircraft of the earlier wave with fighters in pursuit. Fortunately we passed unseen along the low cliff-edge and in a matter of minutes dropped into line astern and made a fast climb to 1,000ft at the edge of the airfield to go in for a front gun attack. There were a number of Meteors on the ground and also Mosquitoes, Brigands and others. All six of our aircraft were able to attack before a lone Meteor on the circuit closed in.

Manœuvring in a remarkably skilful manner, the Meteor 4 joined almost at once by a fellow, made repeated attacks from astern, even though it meant reducing speed to suit our 120 knots, and flying at less than 50ft. Although we attacked our target, we had to concede 100 per cent casualties. Similar raids on Martlesham Heath were more successful; complete surprise was achieved and the aircraft were not intercepted.

Refuelling arrangements for the foreign visitors were in the hands of the R.A.F. A French Vampire is having its tanks replenished.

STRATEGY AND TACTICS

BOMBER stations had rather a wearing week-end, for the likelihood of widespread fog on return caused night operations to be postponed twice, and some units in the sizeable force of Lincolns and Lancasters did not get off until Sunday evening.

A member of *Flight's* staff listened to the planning of the Mosquito low-level marking force operating from Lincolnshire. They employed tactics similar to those in the late war and a force for a "spoof" attack, carefully timed, was sent off in advance. At Waddington, nearby, a large force of Lincolns representing several squadrons received its briefing during the afternoon, and was by early evening on its way to the industrial target in the North Midlands. The routes both in and out were planned to give the best exercise to all concerned in attack and defence, and they entailed flying out over the North Sea, over Holland, Belgium and France, and then turning west towards the Atlantic, and finally north to fly in over the south coast of England. Operating heights for the bomber forces varied from 10,000 to 25,000ft.

THE EAGLE'S SHARE

A VISIT to Marham, Norfolk, one of the three bases from which the U.S. Air Force's 43rd (Refuelling) Bombardment Group operates, gave encouraging evidence of the high degree of Anglo-American co-operation in military air affairs.

The Group, which began its 90-day stay in Britain last August, consists of three B-50 squadrons, the 63rd, 64th and 65th, flying from, respectively, Sculthorpe, Marham and Lakenheath. Dispersed at each station are a number of B-29s which, devoid of gun turrets and carrying extra fuel in their bomb-bays, act as tankers for the larger B-50s.

On Saturday afternoon we flew with a force of the tankers which, after rendezvous at 25,000ft over Bremen, were to cross the east coast of Britain at Yarmouth in an attempt to divert the fighters from the main U.S.A.F. effort—a formation of B-50s which followed 20min behind us at 35,000ft, with the Millwall dock area as their objective. Whatever their reasons, the defences failed to react, and we returned to base unmolested. The B-50s reported two interceptions at 35,000ft some six to eight minutes' flying time from the target. After "bombs away" bad weather was encountered and they descended to 25,000ft, where some half-dozen fighters made another attack.

During Saturday night, 64th Squadron B-50s proved that the U.S.A.F. is not restricted to day operations alone—and appeared to set the defences too severe a test. The bombers took off from Furstenfeldbruck, in the U.S. Zone of Germany, and made a night attack on North London at 35,000ft. They were not intercepted.

Flying at the same altitudes as on Saturday, both Stratobombers and Superforts were out again in force on Sunday. Visibility was splendid, and impressive condensation patterns traced the progress of the bombers and the numerous Meteors and Vampires which intercepted them.

AUXILIARY ENTHUSIASM

ROYAL Auxiliary Air Force squadrons and Fighter Control units were given a real taste of simulated war-time conditions in the Colerne sector. For most of the airwomen of the Auxiliary Fighter Control units it was their first experience of operations on a large scale. Many had given up their working time and travelled great distances under adverse weather conditions in order to attend. An air-lift by Dakotas of Transport Command brought Auxiliary F.C.U.s from places as far away as Glasgow, Birmingham and Northolt to man a complete fighter sector for the first time.

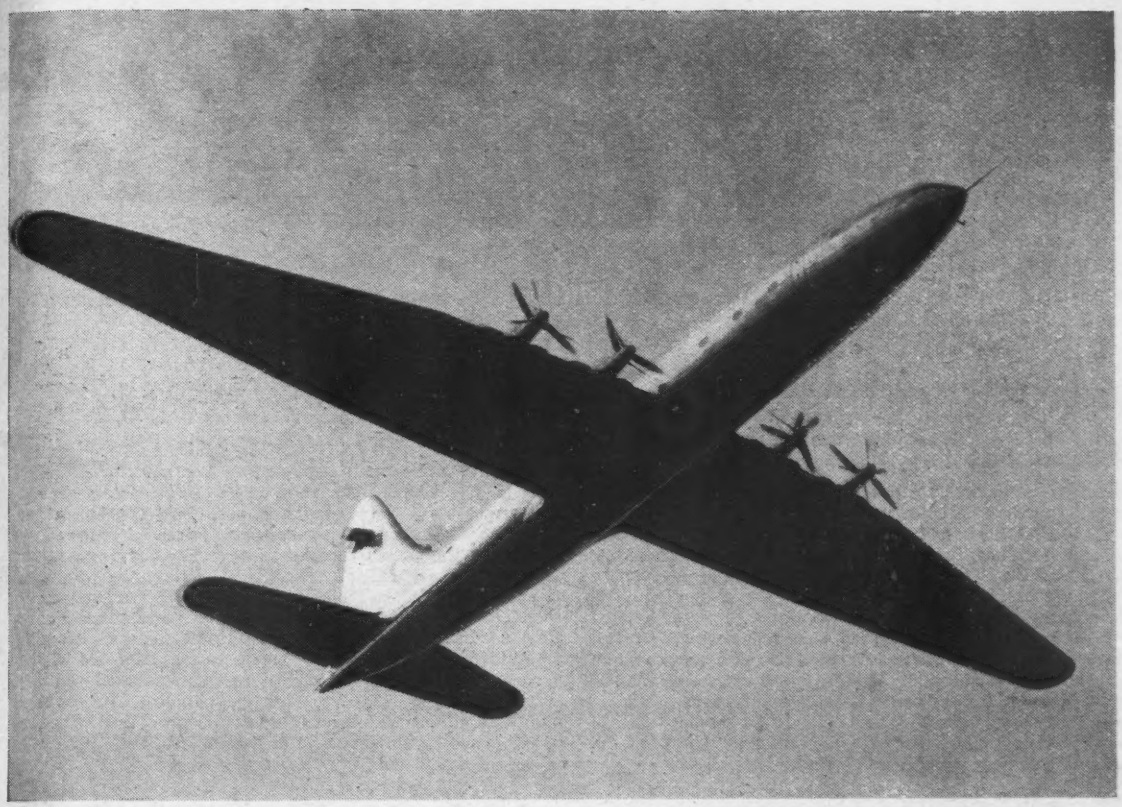
Of these, only 3604 (County of Middlesex) F.C.U., under the command of W/C. J. Cherry, O.B.E., and based at Stanmore, managed to reach Colerne in full strength. Extreme keenness and enthusiasm was the keynote of their efforts, and, considering the fact that, although well-trained, they were as yet "unpractised" under operational conditions, their technique was good. Two Auxiliary Meteor squadrons were to have been based at Colerne but, due to bad weather, only 500 Squadron (Meteors) were able to operate from there. The rest of the sector was manned by 614 and 502 Auxiliary Squadrons at Llandow and 609 Auxiliary Squadron at Chivenor, all using Spitfire 22s.

Routine sector patrols occupied Saturday afternoon, and only three intruder raids materialized. Colerne airfield was successfully attacked by a section of Hornets at approximately 1530 hr, and they also attacked Llandow airfield shortly afterwards. There they were intercepted by Spitfires of 614 Squadron, who carried out stern and quarter attacks and followed the intruders to the coast. Five Harvards attacked Chivenor airfield, but came in too low and failed to spot aircraft parked near the trees. They were chased and attacked by a section of 609 Squadron, which was on airfield patrol at the time of the incident.

No further activity was seen until Sunday morning, when numerous intruder and one area raid of 30 plus were plotted throughout the sector. The area raid turned out to be a formation of Ansons heading towards Gloucester, and interception was carried out by a Spitfire section. No. 500 Squadron (R.Aux.A.F.) (Meteor 3s) gave an exceptionally good display of "scrambling" technique, and many of their 18 scrambles on Sunday were made in approximately one minute.

Two Hornets again attacked Colerne at low level at 1530 hr, but were "claimed" by the 40 mm Bofors guns surrounding the airfield as they pulled up to 300ft to turn into position for a further attack.

All fighter squadrons were very active during Sunday afternoon, but pilots expressed the opinion that the small number of successful interceptions was due to the comparative inexperience of controlling personnel and to the extremely low level at which most of the intruder attacks were carried out. It was, however, valuable practice for the "week-end" Air Force and notable for the remarkable enthusiasm displayed by pilots, ground-crews and control personnel alike.



The never-to-be-forgotten moment when, after a period of the most commendable effort on the part of the Bristol Company and others associated with the Brabazon project, the great machine was presented at the S.B.A.C. Display, Farnborough on September 8th.

BRABAZON BULLETIN

Latest News from Filton : A Salute to Suppliers

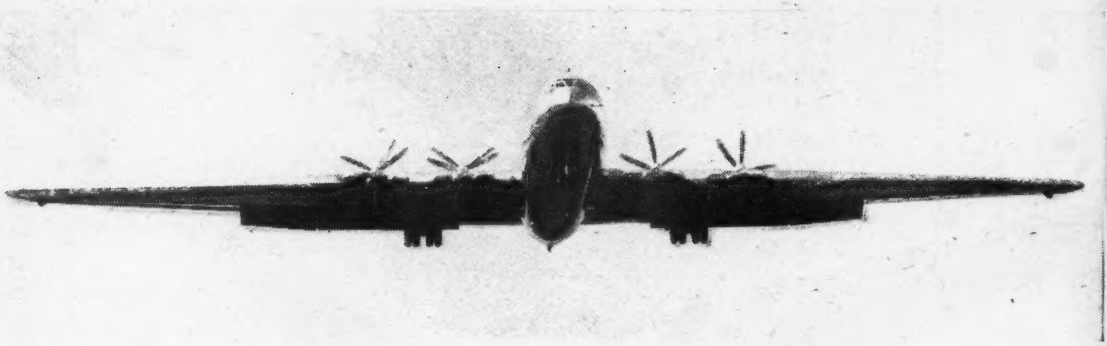
AFTER the first flight on September 4th, which was of 25 minutes' duration and was described in *Flight* of September 8th, the Brabazon I flew for 2½ hours on September 7th and for a further 1 hr 35 min on September 8th, when Mr. Pegg presented her at the S.B.A.C. Display. During the week ended September 17th she emerged once more from the Filton assembly hall, wherein adjustments and checks had been under way, for an engine run; another run is scheduled before the next series of flights.

Mr. Pegg's pronouncement on the maiden flight—"a very comfortable ride"—is enthusiastically endorsed by members of the crew, who remark especially on the exceptional smoothness. Vibration points have to be diligently sought for, and a threepenny-piece will remain on edge anywhere in the fuselage. One flight-observer confessed that, emotionally, he was more affected by newsreel shots of the first flight than by his actual participation.

Never has such a quantity of "gadgetry" been concentrated in a single aircraft. Much of this is described, or at least referred to, in the special photogravure supplement which occupies the succeeding pages; but, patently, even this lavish apportionment of space does not allow anything approaching complete coverage of the myriad details involved. The most cursory mentions under the heading "Suppliers" on p. 432 may denote entirely novel and highly ingenious items.

Every contributor to the design and construction of the

Mr. Hubert M. Brookes, a Birmingham modeller, with the 1/120-scale Brabazon II and 1910 Bristol Box Kite which he built for the makers of both these famous—and contrasting—aircraft. He spent over 1,000 hours on the miniature "Brab.", which is composed of 245 separate parts.

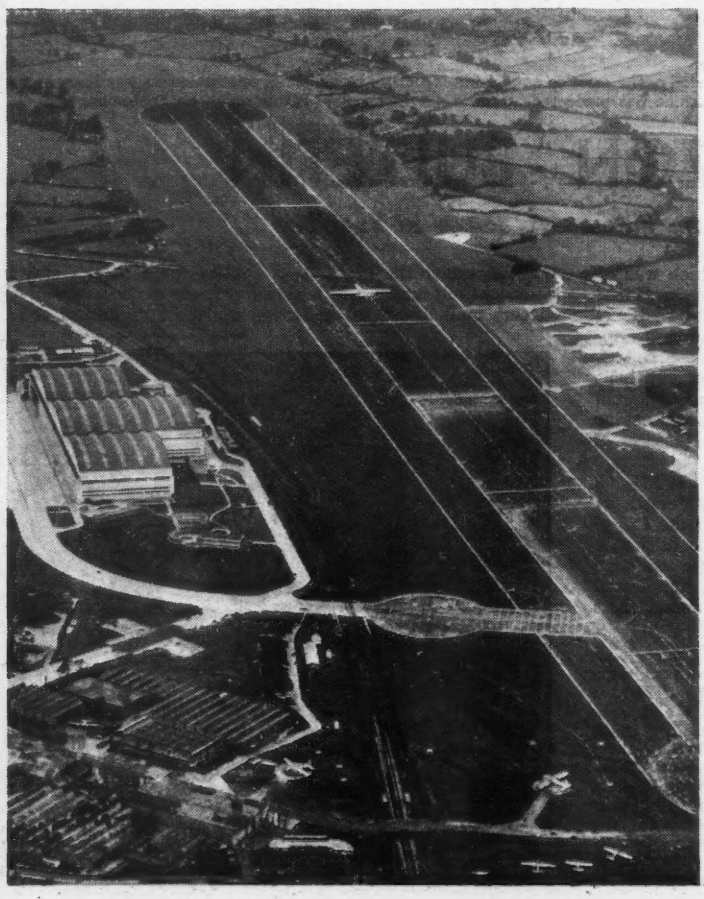


Approaching for her first landing on September 4th, after 25 minutes in the air, the Brabazon I presents a lordly spectacle. The vast expanse of the trailing-edge flaps, the eight-tyred main undercarriage and the great depth of the wing are especially well shown.

Brabazon Bulletin . . .

"Brab" is naturally proud of his association with it, especially where his co-operation has called for some extra-special effort. The satisfaction which comes of a difficult job well done has, for instance, rewarded the firm of George Salter and Co., Ltd. Not only did Salters supply a very large number of springs, but, in response to a telephone call three days before the first trials were due, to the effect that last-minute "mods." demanded some new springs, worked through the night and had them ready for collection on the following morning. Many performances of similar merit lie behind the production of the great aircraft.

Left to roam over the Brabazon (a somewhat fanciful suggestion, calculated to send Mr. Chard and the Bristol wardens clean through the roof of "Brabazon Hall"!) a student of aircraft construction and equipment could spend engrossing days. He might choose any component at random and seldom fail to discover something unusual, or appealing to his engineering sense. In the ailerons, for instance, he would note the G.E.C. heavy-alloy balance weights, the effect of which is to prevent inadvertent movements of the controls; each weighs 7½ lb, but measures only 6in × 2in × 1in, so that six of them provides a total of 45 lb weight in an astonishingly small space. On the flight deck, apart from the array of instruments and controls presented on pp. 426-427, his eye would not miss the Eversheds all-electric throttle controls, providing absolute synchronism of movement, since the slave units on the engines move at exactly the same speed as the control levers. The variable-pitch airscrew controls are identical in principle. Such instances of ingenuity, of course, are well-nigh inexhaustible.



Among those items for which "outside" firms may take credit are some which, though vital to the operation of the Brabazon, are not an intrinsic part of the aircraft itself. For example, on a visit to Folland Aircraft, Ltd., early this year, a member of *Flight's* staff discovered that not only was this company responsible for the detail design and construction of the rudder, elevators, ailerons and flaps, but that an impressive quantity of special ground equipment also stood to Folland's credit. This included massive transport trolleys for the undercarriage, outer wing, rudder, elevators, ailerons and flaps; slinging gear; towing gear; servicing platforms; wind and tail steadies; and sundry tools and trestles.

Much detail design of Brabazon I and II components has been sub-contracted; thus, Auster Aircraft are responsible for major components of the Mk II tail.

On the day preceding the first flight: The Brabazon undergoes her taxying trials. This view affords a unique comparison in size as between the aircraft, the assembly hall and the runway. In pondering this picture the reader may find it helpful to bear in mind that the overall width of the assembly hall is 1,052ft, the span of the Brabazon 230ft, and the runway length and width respectively 2,750yd and 100yd. From the western end of the runway, for which she is seen to be headed, the "Brab." took off on her maiden flight. Loaded to a weight of 210,000lb (of which 30,000lb was fuel), she was airborne after a run of about 500yd.

THE STORY OF THE BRABAZON

Compiled by H. F. KING, M.B.E.
(Assistant Editor)

A Comprehensive Appraisal of Britain's Greatest Airliner : Vicissitudes of Development : Prototype and Operational Versions Studied

SUCH is the compass of the Bristol Brabazon project that even now, with flight-testing in progress, numerous aspects of this vast national venture are unfamiliar, even among people who have assisted daily towards its fulfilment. The purpose of this supplement, therefore, is to survey at adequate length the history and characteristics of the Brabazon. Fittingly prefacing the study are some observations, set down expressly for our purpose, by Lord Brabazon of Tara, chairman of the originating committee, and Sir Miles Thomas, chairman of B.O.A.C., to which Corporation the Brabazon II will be entrusted.

Persistent and heavy demands on public funds appear largely to have obliterated the memory that the Brabazon was conceived as a money-*making* proposition. Some £6½ millions for the Mk. I and Mk. II prototypes, and about £5½ millions for the Filton assembly hall and runway, represent about four times the estimated cost of the two prototypes alone ; but, granted an adequate operational life, a small fleet of Mk. II Brabazons may yet earn millions in dollars.

From Lord Brabazon of Tara P.C., M.C., F.R.Ae.S.

TOWARDS the end of the war, the Secretary of State for Air and the Minister of Aircraft Production set up a committee to voice users' requirements as to the future types of civil aircraft required. It was a very talented committee, and I was privileged to be its chairman. It held, I think, something like sixty meetings and made recommendations as to the necessity of building five new types.

After so many years have passed it is interesting to see what has been evolved from the recommendations of the committee.

Starting at the wrong end, so to speak, the Brabazon recommendation No. 5 has produced the Dove, which was 5A, and the Marathon, which was 5B. Brabazon recommendation No. 4 was for a full-jet transport machine which has just been flown and is, of course, the wonderful Comet. Brabazon 3 was never ordered but was, in fact, a recommendation to produce new four-engined civil machines of about 100,000 lb weight, to replace the bomber types. It has, however, recently been ordered by the Ministry, but very late. Brabazon 2 produced the Ambassador. In Brabazon 1 we desired a machine which would fly non-stop New York to London—that was its job, and nothing else. Technical reasons forced this machine to be ultra-big to take its useful load and fuel and it was, indeed, not one step forward in size but about three steps forward.

All the time we had in view the possibility of gas-turbine propulsion instead of piston engines. Much research work has been done on the Bristol machine which will be common to all big aircraft. A new gas turbine is being evolved, a new airfield has been put down and vast, much needed hangars constructed, with the result that the bill, all put down to the building of this machine, has swollen to a vast size. The Bristol Company has tackled the project with painstaking care, and it is the hope of everyone in this country that this pioneer experiment in great aircraft will be the success it so richly deserves.

From Sir Miles Thomas D.F.C., M.I.Mech.E., M.S.A.E.

FOLLOWING the decision in 1943 by M.A.P. and the Air Ministry to order prototypes of the Bristol 167, B.O.A.C. was asked to associate itself closely with the design and development; this association would include advising M.A.P. and the Bristol Aeroplane Company on the layout of the aircraft and its equipment. Before mentioning the more outstanding examples of the collaboration, it is necessary to refer briefly to the broad approach followed by B.O.A.C. in seeking the objectives of safety, performance and earning power.

The original conception of the Brabazon Committee was largely based upon the prestige value of a direct London-New York service coupled with the

THE STORY OF THE BRABAZON

A. E. Russell, chief designer, Aircraft Division, Bristol Aeroplane Company.

F. M. Owner, chief engineer, Engine Division, (right), and S. Mansell, chief engine designer, on the day of the first flight.

A. J. ("Bill") Pegg, chief test pilot.

regularity to be gained by elimination of the uncertainties of refuelling in Newfoundland. This meant a highly specialized design, and the official view was that the Bristol 167 represented the size required to deal with this very large air mileage requirement. The design of the Mark II prototype, now more than half completed, shows the improvements made—they include, in particular, greater operational flexibility; this should be of great value, however it may be decided to operate the aircraft.

With any commercially competitive scheduled air service, high fleet utilization must be a first aim. The larger the unit the more difficult this becomes and correspondingly greater emphasis is placed on both mechanical dependability and operational regularity. The former means designing for consistency of performance and easy maintenance from the outset; the latter means—particularly where flight cancellations due to adverse terminal forecasts would have catastrophic repercussions upon planned aircraft movements and thus on booking office and hangars—all-round reductions of operating limits through better route facilities and operating techniques. It is proposed to refer specifically to some of the development done up to this stage under the first heading as the result of collaboration between B.O.A.C. and the firm:—

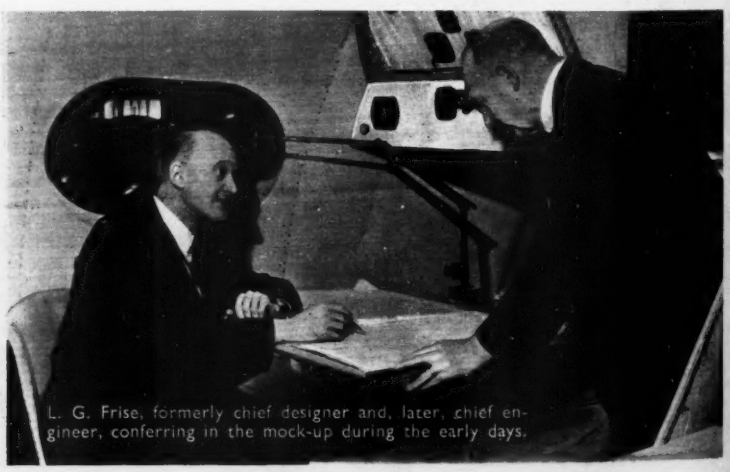
(1) **Safety:—**
- (i) Best location of emergency exits; details and location of life-saving equipment, etc.
- (ii) Design criteria for airframe and engine anti-icing.
- (iii) Advice on fire precautions.

(2) **Increasing "payability":**—The original specification was for a 50-72 passenger aircraft for direct operation between London and New York throughout the year. This target would have seriously restricted the revenue potential of so large an aircraft. Studies by B.O.A.C. which, incidentally, meant establishing *de novo* the best method of operating turbine-powered aircraft, have raised the target to at least 100 passengers by more efficient use of fuselage volume.

(3) **Maintenance features:**—The wealth of B.O.A.C.'s experience has been put into the redesign of many items to improve maintenance; this is possibly B.O.A.C.'s most valuable contribution. Because of size alone there has had to be much specialized design, including handling equipment for ground use.

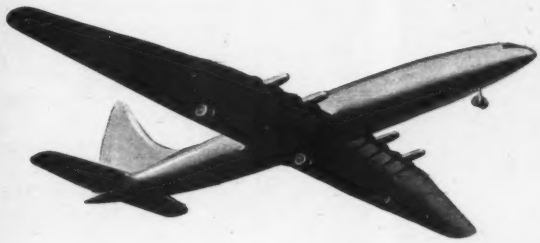
(4) **Increased operational flexibility:**—Continuous operational and design investigations with the firm have resulted in:—
- (i) Development of an eight-tyred four-wheel bogey undercarriage to reduce runway bearing loads;
- (ii) Improvements to the cabin air supply, thus increasing passenger capacity, which was previously limited by this feature;
- (iii) Raising the original structural wing bending moment limit to the maximum payload which could be carried, even on short sectors.

(5) **General operating advice:**—In particular,
- (i) Policy for the electrical systems.
- (ii) Methods of operating reversible-pitch airscrews, since widely adopted.
- (iii) Wheel braking systems.
- (iv) Take-off and landing procedures, thus influencing undercarriage and flap design, and their operation.



L. G. Frise, formerly chief designer and, later, chief engineer, conferring in the mock-up during the early days.

An early proposal, with pusher propellers and vee tail.



The Brabazon I as she first flew on September 4th, 1949.
(*Left*) Showing undercarriage layout abandoned late in 1945.

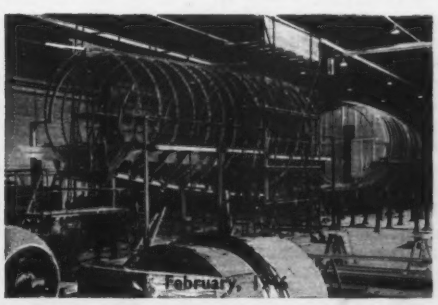
BACKGROUND

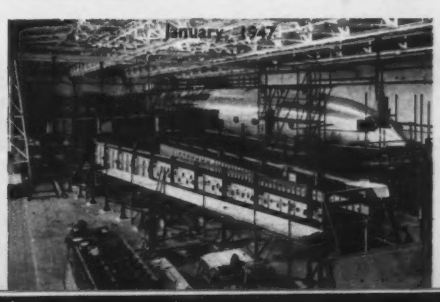
WITH admirable prescience, the Government decided in 1942 to take preliminary steps to safeguard the post-war department of British aviation. An interdepartmental committee, under the chairmanship of Lord Brabazon of Tara, and consisting of representatives from the Air Ministry, Ministry of Aircraft Production and Ministry of Production, was appointed to prepare outline specifications of aircraft types required for commercial utilization. On February 9th, 1943, the committee recommended (as mentioned by Lord Brabazon himself on the first page of this supplement) that designs for five new types of aircraft should be started immediately. The first of these was a London-New York landplane with a still-air range of 5,000 statute miles; this type was listed as top priority for allocation of design and prototype-construction effort, and it was estimated that the first batch of production machines would be unlikely to appear much before the end of the fifth year.

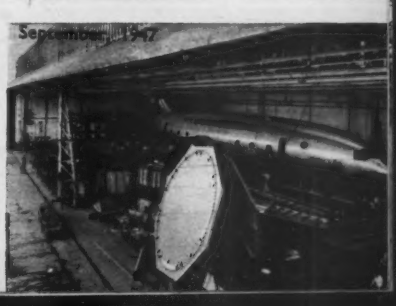
A second Brabazon Committee was appointed to consider the types recommended and to prepare, with due regard to traffic needs and economy of operation, a list of requirements for each type in sufficient detail to provide a working basis for design and development. In their first interim report (August, 1943) they gave priority to aircraft for the London-New York service and recommended that no time be lost in the issue of a specification, adding that if the exacting operational requirements of this service were to be met, financial considerations must necessarily be subsidiary. A detailed list of requirements was also prepared, including the provision of accommodation for a minimum of twenty-five passengers in convertible berths. Meanwhile, the Bristol Aeroplane Company had been asked by the M.A.P. to make design proposals, and in May, 1943, after submitting a memorandum, were told that the Ministry intended to order two prototypes. The Bristol Company was selected because it was the only firm with sufficient design capacity available at the time; it had an excellent record on structural work and, manufacturing aero engines also, would be responsible for both branches of development. In 1942 the company had tendered proposals for a bomber of similar size to the Brabazon Type I.

To the second Brabazon Committee B.O.A.C. had suggested that the aircraft should have a passenger capacity of about twenty-five, together with mail and a quantity of cargo; they expected the gross weight to be about 150,000 lb. The Bristol Company, however, maintained that to meet

Progressive views on this and the following page show the Brabazon I's huge structure taking form; the move from No. 2 Flight Shed to the new assembly hall during October 1947, and the coincident naming ceremony; the final stages of erection, resonance testing and engine running. Lastly she is seen in flight on September 8th, 1949, over the S.B.A.C. Display at Farnborough.







October, 1947

October, 1947

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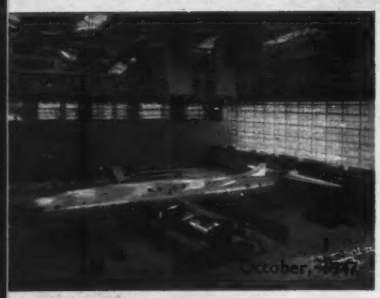
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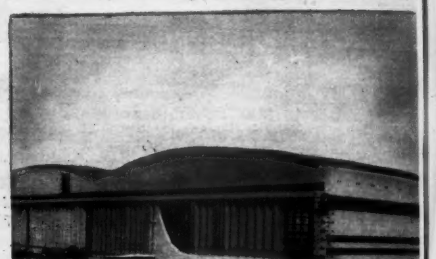
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THE STORY OF THE BRABAZON . . .

the exacting requirements of the direct London-New York flight, a 250,000-lb aircraft was essential; as payload is proportionate to gross weight, this raised the passenger capacity to about seventy west-bound and a hundred east-bound. Although the aircraft envisaged was much larger than originally contemplated, B.O.A.C. accepted the Bristol view that the proposed aircraft was the smallest which could do the job.

Bristol Centaurus piston engines were originally selected, but in view of gas-turbine development it was decided in November, 1945 that for operational purposes the Brabazon should be powered with Proteus turboprops. Had the aircraft been originally designed with Proteus units in view it might have been slightly smaller, but would nevertheless have been so much larger than existing types that development costs would not have been appreciably reduced.

Not until March, 1946, was it decided that the two prototypes should be assembled and test-flown at Filton. In the meantime, the Bristol Company had pursued design work, constructed a mock-up and embarked on preliminary construction of the Mk. I prototype. Reference to some of the numerous changes in design, resulting from the extensive research and development work put in hand, is made on other pages. Valuable co-operation was afforded by the Royal Aircraft Establishment and much of the research necessitated was of great value to the aircraft industry as a whole. To review progress, conferences of representatives of all interested parties were summoned every three months by the Ministry of Supply. There were also panels which dealt with various technical matters and met each month under the chairmanship of a member of the Bristol Company.

During early discussions the Ministry of Supply set a target for the first flight of the Mk. I prototype at April, 1947, but this was later admitted to have been unrealistic. Nevertheless, it was hoped that the first flight would take place in August, 1948. As all the world knows, the Brabazon I first left the ground on Sunday, September 4th, 1949. The target date for the Proteus-powered Mk. II prototype was autumn, 1949, but the Bristol Company described this as "hopelessly optimistic." At the time of writing the first Mk. II aircraft is about half complete and may fly in 1951.

In March, 1946, the Ministry of Supply decided to locate at Filton an airfield to meet the requirements of the Brabazon I, involving the construction of the special runway and assembly hall described elsewhere.

December, 1948

May, 1949

September, 1949

THE STORY OF THE BRABAZON . . .

STRUCTURE

In overall configuration the Brabazon I (Bristol 167) is surely, and irrespective of class, one of the most graceful aircraft ever to take the air. The wing, however, is of inordinate thickness in order to accommodate the Centaurus engines, and, although weight-savings will be effected in the Mk. II wing, the thickness will not be decreased.

Though a fuselage of "figure 8," or "double-bubble," cross-section would offer floor space for extra payload, should stops be made at Gander and Rineanna, two important effects would arise from its adoption: (1) the weight of the fuselage, floor, furnishings, pressurizing and other equipment, would be increased in proportion to the accomodation; and (2) the wing structure weight would be greater, due to the increased bending moment resulting from the transfer of load from the fuel tanks to the body.

Choices

The choices for the Atlantic, Mr. Russell has pointed out, appear to be (a) a single-deck fuselage capable of making the non-stop westbound Atlantic crossing with sleeping accommodation for all passengers and with a payload amounting to about 8 per cent of the all-up weight; or, seating accommodation for 50 per cent more passengers, probably on a stopping service; alternatively (b) a double-deck fuselage, unsuitable for the non-stop westbound crossing, but with sleeping accommodation appropriate to a passenger payload equivalent to 12-13 per cent of the all-up weight on the stopping service, and with considerably more seating capacity on alternative shorter runs. The Bristol conclusion was that, for aircraft of about 300,000 lb gross weight, a double-deck fuselage is not the best arrangement if a range exceeding 4,000 miles is a primary requirement, and that a single-deck body gives greater flexibility for alternative passenger arrangements until conditions of transatlantic operation become better established.

The fuselage skin plating of the Brabazon I is carried on Z-section stringers and rolled, channel-section frames. Three weights of stringer are used (all of Z-section), two extruded and the third a rolled member. This use of three stringer types points to the very careful watch kept on weight/strength factors. The heavier of the two extruded types is used exclusively in the central trunk portion of the fuselage, in way of the wing centre-section where, naturally, the greatest bending moment occurs. These stringers terminate in pairs gathered into a vee, at the apex of which the lighter extruded stringers pick-up. Positioning of the several vee-blendings is symmetrically staggered to conform to the bending moment curve; but the median positions are roughly at the centre-section leading-edge forward, and a few feet rearward of the centre-section trailing edge aft. In the rear half of the fuselage the light extruded stringers are used; but in the forward half they extend approximately to 18ft forward of the leading edge. Here they give way to the lightest rolled stringers, which continue up to the nose, this being made possible by the rapidly diminishing bending moment in this region.

It may be remarked at this point that, after skinning of the fuselage had been completed, the decision was taken to increase torsional and flexural strength by connecting the frames to the stringers by a series of cleats, extending through the main fuselage and rear body. Attachment is made at the points where the stringers pass through the cut-outs cropped into the outer frame periphery.

An interesting sidelight on the stringers, which emphasizes the design preoccupation with weight and stress distribution, is that both types of extruded stringer have their free flanges taper-machined. When it is realized that in the centre-section trunk of the fuselage there are no fewer than 132 stringers, and the machining gives a saving of weight per stringer of the order of 6 per cent, it may be understood how important an item this seeming elaboration is in reality. The fact that the machining is such as to give a tapering flange-thickness ensures a gradual change in stringer section, and avoids any stress concentration.

For the same basic reason of weight/strength factors, the fuselage skin plating is of varied thickness, being 14 s.w.g. in the centre trunk portion and diminishing through 16-gauge to 18-gauge panels at the extremities. Further, standard sheets are produced to thickness tolerances wider than the makers could accept—in that if too many sheets were near the top limit the aggregate increase in weight would be an expensive penalty—and so special sheets were rolled to tolerances in which the emphasis was in keeping thickness nearer the minimum rather than the maximum permitted. Equally specialized treatment was accorded the pressurizing aspects of the problem.

There are three main longerons in the fuselage, one on the roof centre-line and the other two low down on the base curvature. The "ridge-beam" is made up of two light rolled channels placed back-to-back to form an I-beam; but the bottom longerons are L-section extrusions, the lower arm of the L being curved according to the skin contour. Above and below the windows run extruded channel stringers-cum-longerons. The floor runs at much the same level throughout the fuselage except (i) at the flight deck and tail end, where it is raised a few inches, and (ii) in the central trunk portion, where it is raised to a height tangential with the wing centre-section top surface.

Five bulkheads divide the fuselage. The first occurs at the rear of the flight deck, and is stabilized on both faces with large extruded members, those on the forward face being of channel-section and those on the rear face Z-section. Vertical posts of channel-section—which become I-section lower down—are fitted on the rear face and pick up to the side walls of the nose-wheel well. These side walls are diaphragms which pick up to the vertical flanges of the main longerons and are finished at their top edges with L-extrusions forming T-booms. The nose-wheel well extends back about 11ft from No. 1 bulkhead, and one frame aft of the well's rear transverse wall is the second bulkhead to which the side walls of the well extend. No. 2 bulkhead has a flush forward face, the vertical and horizontal Z-extrusions for stabilizing being on the rear face. However, channels which blend into I-sections are fitted vertically on the front face to pick up the nose-wheel well side-wall extensions, and about 7ft 6in above the floor an extruded lintel member is also fitted on the forward face.

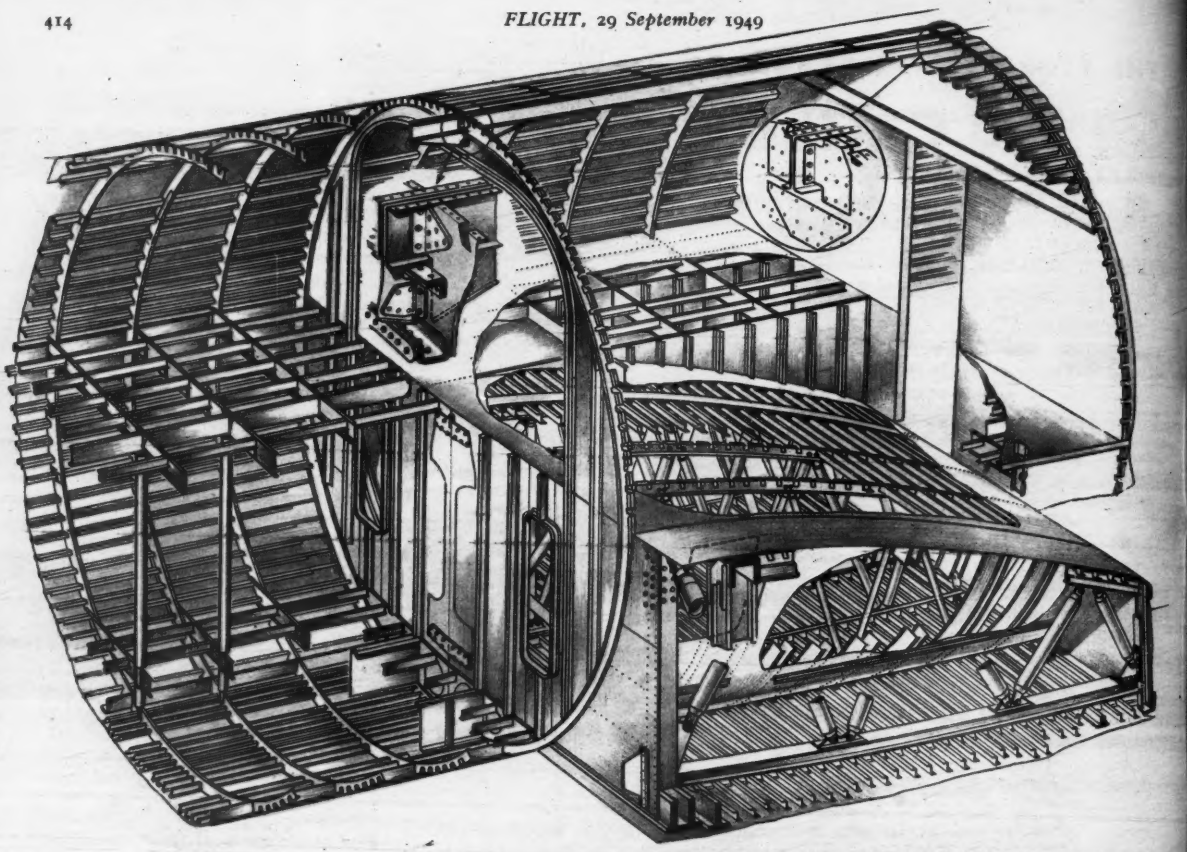
The third bulkhead is a fairly light structure, stabilized with vertical and horizontal rolled Z-strips on its after face, and fitted with square-section hollow extruded door frame-posts of light gauge. Immediately aft of this bulkhead is a staircase leading down, port and starboard to the galley, and a central staircase leading up to the bar lounge.

Spar Seal

About halfway along the fuselage trunk portion, where the front spar passes through, it is formed with a diaphragm web for pressure-sealing, and this web is carried up on each side in arms to form a "horseshoe," the tips of which are brought together on the roof centre-line. The periphery of the member is bounded by a large extrusion which, of square-section centrally on each side, is progressively machined away to an L-section at top and bottom. The interior profile of the horseshoe is bounded by a channel-section member, and to port and starboard on the forward face a box-section vertical stabilizer is used.

At the rear-spar station a not dissimilar fashion obtains, in that the spar web is formed as a pressure-sealing diaphragm which is integral with the bulkhead (No. 4). Last of the bulkheads, No. 5, is actually the rear-pressure diaphragm, and on its forward face are built massive box-section stanchions to the top ends of which the feet of the fin front-spar stretch. Four frames aft of this last bulkhead is a U-frame picking up with the tailplane front spar; a further U-frame picks up to the tailplane rear spar.

Joining of the mainplane centre-section with the fuse-



Junction of the centre wing and fuselage, showing fuselage frames, stringers, longerons, and the raised floor structure together with spar frames and essential structure of the centre wing.

THE STORY OF THE BRABAZON . . .

lage presents quite a novel solution of the difficult problem of ensuring adequate sealing of the fuselage internal pressure. Arising from the fact that the centre-section is built as a continuous structure which passes directly through the fuselage, the front and rear spars, in their spanning portions, are formed with diaphragm webs to function as pressure bulkheads. The upper and lower centre-section skin surfaces are also continuous through the fuselage, and, in order to make the wing interior a pressurized compartment, extra skins are applied to the "free" flanges of the centre-section stringers. These internal skins are riveted at their outer edges to angle members, the vertical flanges of which are in turn riveted to diaphragms known as "wing-root ribs," these latter being, in essence, continuations of the fuselage skin through the wing. Thus, a cross-section of the fuselage at this station shows a pressurized compartment above the wing, a pressurized compartment inside the wing, and a pressurized compartment beneath the lower wing surface, the cavities between these three allowing the passage of the centre-section stringers.

Outboard of the fuselage, the centre-section front spar is a girder-type structure, the bottom boom being of $\overline{\Pi}$-section (made up of two T-sections placed side by side), whilst the top boom is a channel-section, these several members all being very sturdy extrusions. Inter-boom bracing is by kingpost stanchions of a massive extruded section, resembling two channels placed back-to-back with a central spine flange, and tying these kingposts together are equally substantial diagonal bracing struts of tubular steel. Behind the two T-extrusions making up the front spar bottom boom is an extruded T-section reinforcing boom.

By comparison, the rear spar is a simple structure comprising a diaphragm web with massive extruded L-section booms. Here, again, in front of the bottom boom is an extruded T-section reinforcing boom to complement that of the front spar bottom boom, as depicted above.

Chordal ribs are fabricated warren-girder-type components, with tubular struts of Hiduminium bracing the contour members. These members are made up with sheet webs, the internal edges of which are reinforced with Z-section extrusions, whilst the outer edges carry T-section extrusions; the latter are machined away, together with the sheet webs, to afford passage for the Z-section spanwise stringers to which the skin is attached. Those chordal ribs bounding the undercarriage bay are of diaphragm type with extra large stabilizing members, and on the centre line of the bay the front-spar kingposts are doubled. In this region on the rear spar, a reinforcing boom is additionally fitted to the top boom of the spar, this extending 10ft 6in on each side of the centre line. At the outboard ends of the inner wing are diaphragm chordal ribs, the space between them housing fuel tanks; to complete the tank cell, the web structure of the front spar at this point is also a diaphragm.

Attachment of the outer wing panels is quite conventional in the fork-end-and-lug/pin-joint fashion, but the outer wing panels are of very different construction from that used for the inner wing. At the 15 per cent chord ordinate is a diaphragm-type spar called the "front tank-spar" comprising a plate web with channel-section booms: this forms the front spar of the outer wing. At the 27 per cent ordinate (that is to say, lining up with the inner-wing front spar) is the front-spar continuum which, in point of fact, is merely a pair of booms with no web structure; this is to give tank clearance and distribute stress between the outer and inner wings.

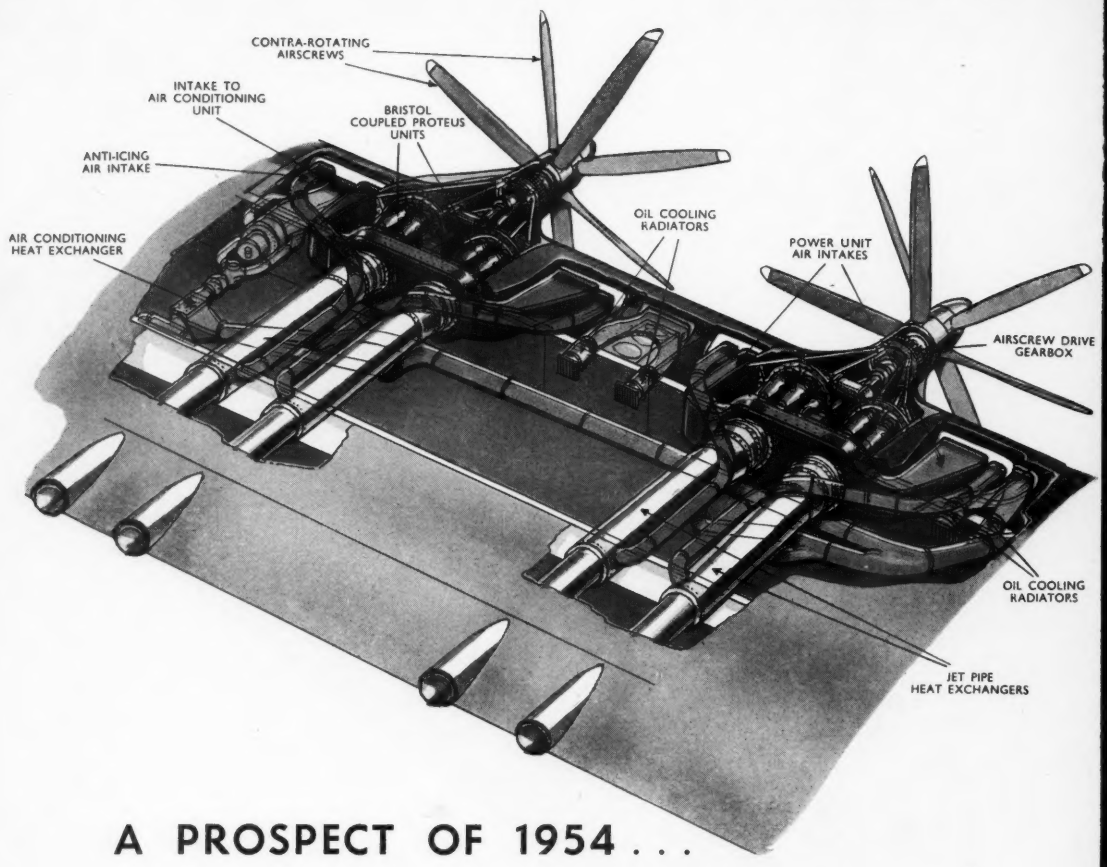
At the 55.2 per cent ordinate is the rear-tank spar, made up with conventional booms and a plate web, this extending only to the outboard end of the tank emplacement; its construction is similar to that of the front tank-spar. At the 68.807 per cent ordinate is the rear spar proper, of normal plate web and L-section boom construction, which

(*Continued on page 423*)

A PROSPECT OF 1954

FORTY thousand feet above the North Atlantic, the Brabazon II is on course for New York. In snug cabins and airy saloons sixty-odd adults doze, read or prop up the bar, while in the rear lounge, serving now as a cinema, a tittering of children at a Disney feature quite drowns the distant hum of turbines.

The date? Some time, perhaps, in 1954; hardly earlier, for the first Brabazon II is as yet only half complete, and the Mk. I is only now entering on a formidable programme of trials; but there is no harm in visualizing, and the reader is accordingly commended to F. W. Beak's painting on this page. With it before him he may care to contemplate Britain's vast new airliner as the Poet Laureate might depict it in a new stanza of *Cargoes*. The serious student, however, will turn to a paper by the Laureate's cousin, Mr. Peter Masefield, for an appreciation of the Brabazon as an instrument of commerce. In its way as much a classic as *Cargoes*, this erudite commentary, *Some Economic Factors in Civil Aviation*, describes the Brabazon as a formidable aircraft, offering prospects of a performance unequalled in competitive types.



A PROSPECT OF 1954 . . .

Turboprops for the Brabazon II

EIGHT paired Bristol Proteus turboprop units will form the power plant of the Brabazon II, and thus powered the type is intended for service on the London–New York run. The compressor of the Proteus is a combined axial and centrifugal unit, centrally located and having the combustion chambers disposed around it. Air enters at the rear of the compressor and traverses the axial stages before passing through the centrifugal stage for delivery to the eight separate combustion chambers. A feature of special interest is the mechanical separation of the compressor and airscrew-driving turbines; not only does this result in simplification of the airscrew system, but it makes for easier starting.

The two individual Proteus units of each pair are mounted side by side, and are attached to the coupling gearbox—a cast-aluminium casing, housing the first stage of the transmission gearing, together with ancillary drives. The gear train comprises a double helical pinion, driven direct by each power-turbine, each pinion meshing with an idler, which, in turn, meshes with a single output gear. Each gear and pinion is supported on ball or roller bearings. The reduction ratio is 3·2:1. Each power-turbine shaft and its pinion is connected through a dog-clutch which can be disengaged hydraulically should it become necessary to isolate a power unit.

Leading particulars of the Proteus are: Length, 113·35 in; diameter, 38·5 in; weight bare, 2,900 lb; compressor turbine speed, 10,000 r.p.m.; airscrew turbine speed, 10,700 r.p.m.; output (sea level, static), 3,200 s.h.p. + 800 lb thrust; output (35,000 ft, 350 m.p.h.), 1,260 s.h.p. + 560 lb thrust; fuel consumption (35,000 ft, 350 m.p.h., airscrew efficiency 80 per cent), 0·510 lb/equiv. h.p./hr.

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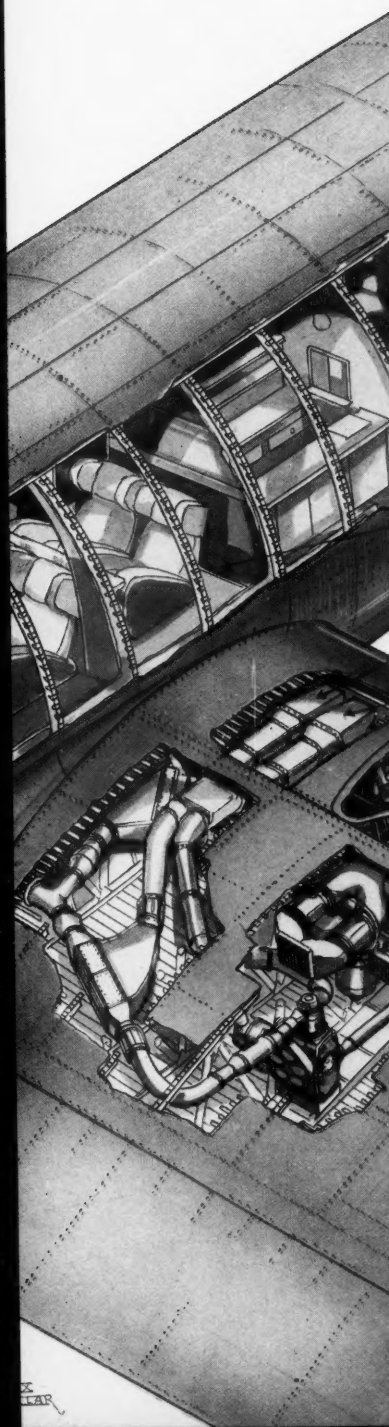
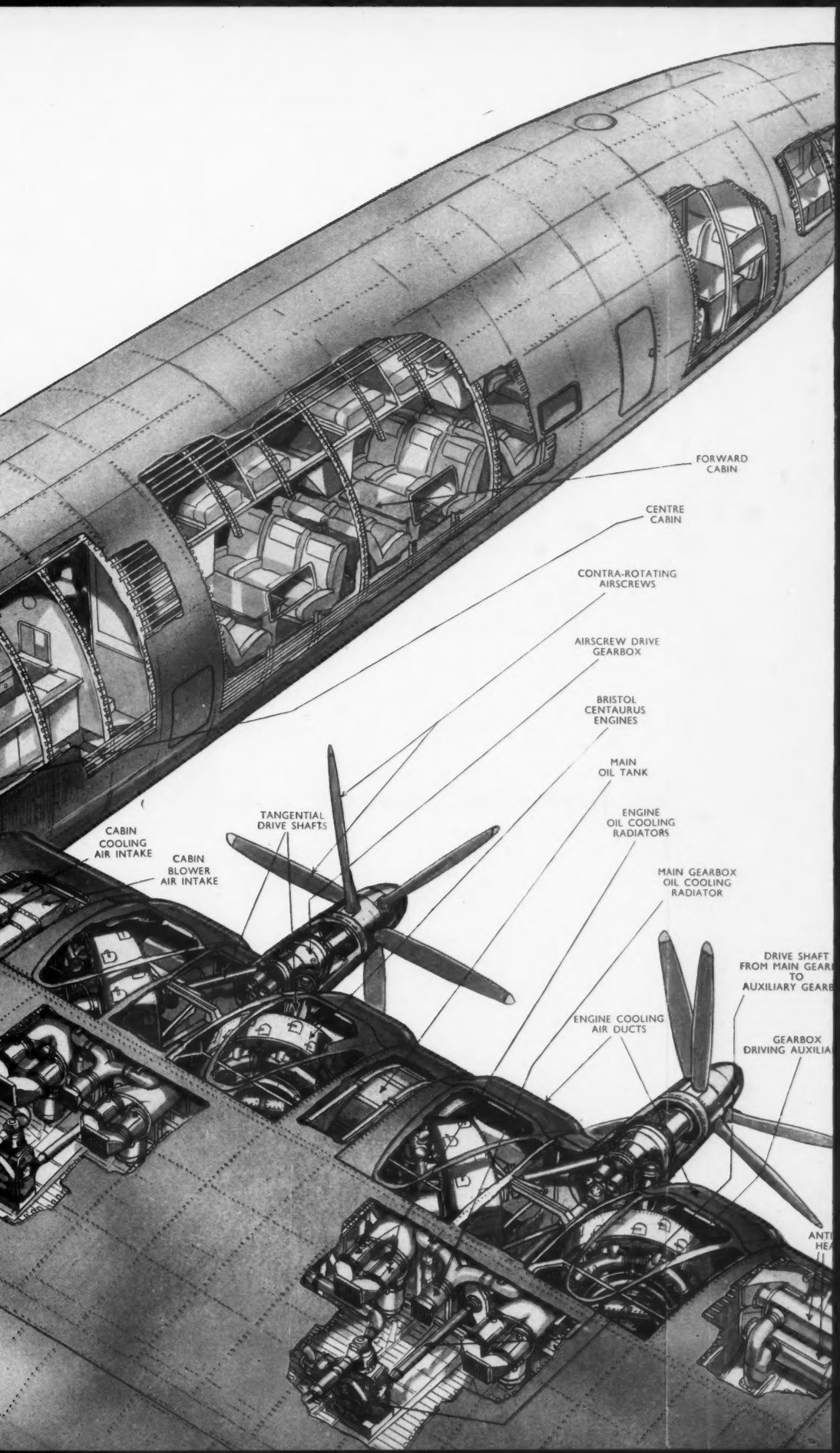
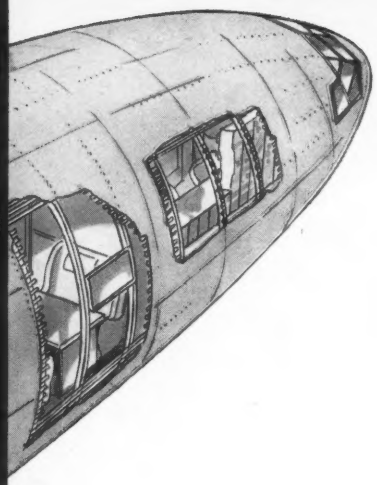



FORWARD CABIN
CENTRE CABIN
CONTRA-ROTATING AIRSCREWS
AIRSCREW DRIVE GEARBOX
BRISTOL CENTAURUS ENGINES
MAIN OIL TANK
ENGINE OIL COOLING RADIATORS
MAIN GEARBOX OIL COOLING RADIATOR
TANGENTIAL DRIVE SHAFTS
CABIN COOLING AIR INTAKE
CABIN BLOWER AIR INTAKE
ENGINE COOLING AIR DUCTS



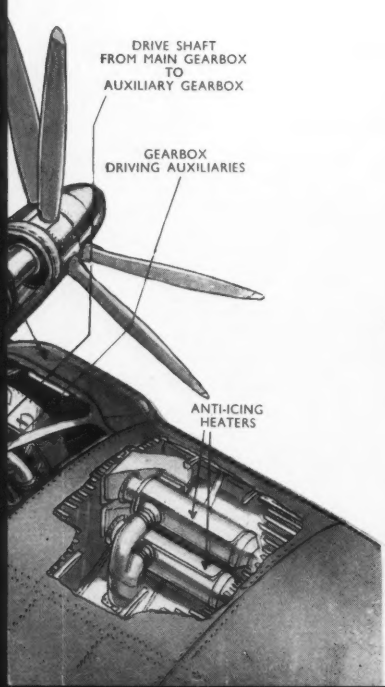
FORWARD CABIN

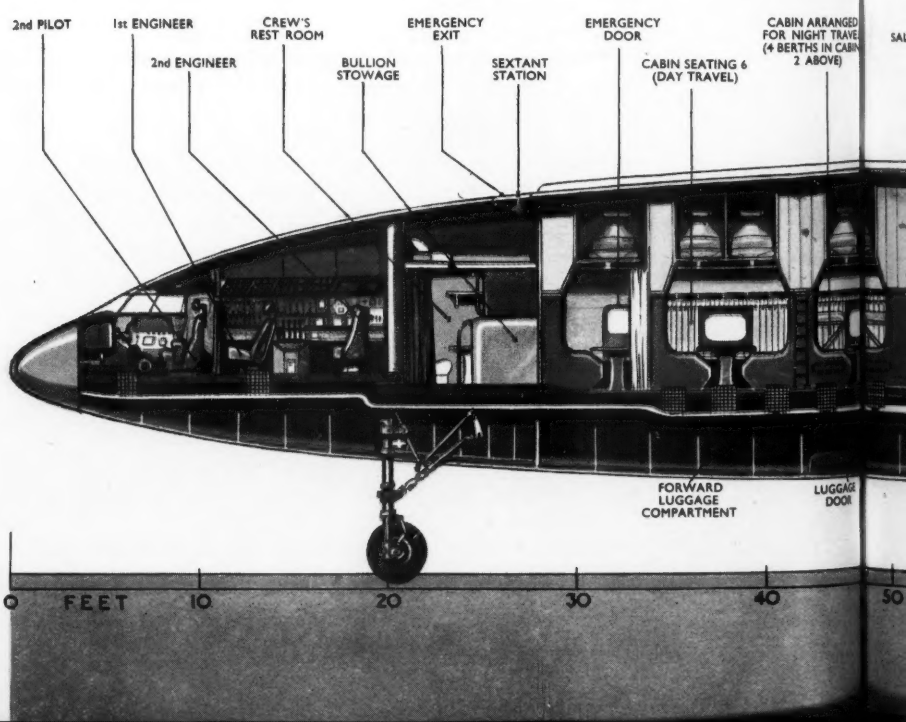
PROTOTYPE AND P

CHARACTERISTICS OF THE MARK I AND SOME GLIMPSES OF

THAT the two marks of Brabazon, though superficially similar, differ considerably in important respects is not, we believe, widely enough comprehended. The specially prepared *Flight* studies on these pages should go far toward rectifying current misconceptions. The Mk. I, portrayed in the left-hand view, is a research and development aircraft and, as it now flies, a mere shell with accommodation only for the flight crew and test engineers with their equipment. After a period of the most gruelling trials to which any commercial aircraft has been subjected it may conceivably be furnished for transatlantic proving flights; but it is to the Brabazon II that Britain looks for a regular non-stop London–New York service, providing unrivalled comfort with high speed. Characteristics of the Brabazon II are described on p. 421, and the amenities of the type are displayed in the large drawing footing these pages. The structure and installations of the Mk. I are dealt with in considerable detail in other sections of this supplement, and technical data are tabulated on p. 422. The following abridged description of the Mk. I is offered for ready reference.

The Brabazon I (Bristol Type 167, Mk. I) is a pressurized, long-range, high-altitude monoplane with a span of 230 ft and is designed to fly at a weight of approximately 130 tons. Dimensionally it may be reckoned as





PRODUCTION FORMS

OF THE LUXURIOUS MARK II, INTENDED FOR TRANSATLANTIC SERVICE

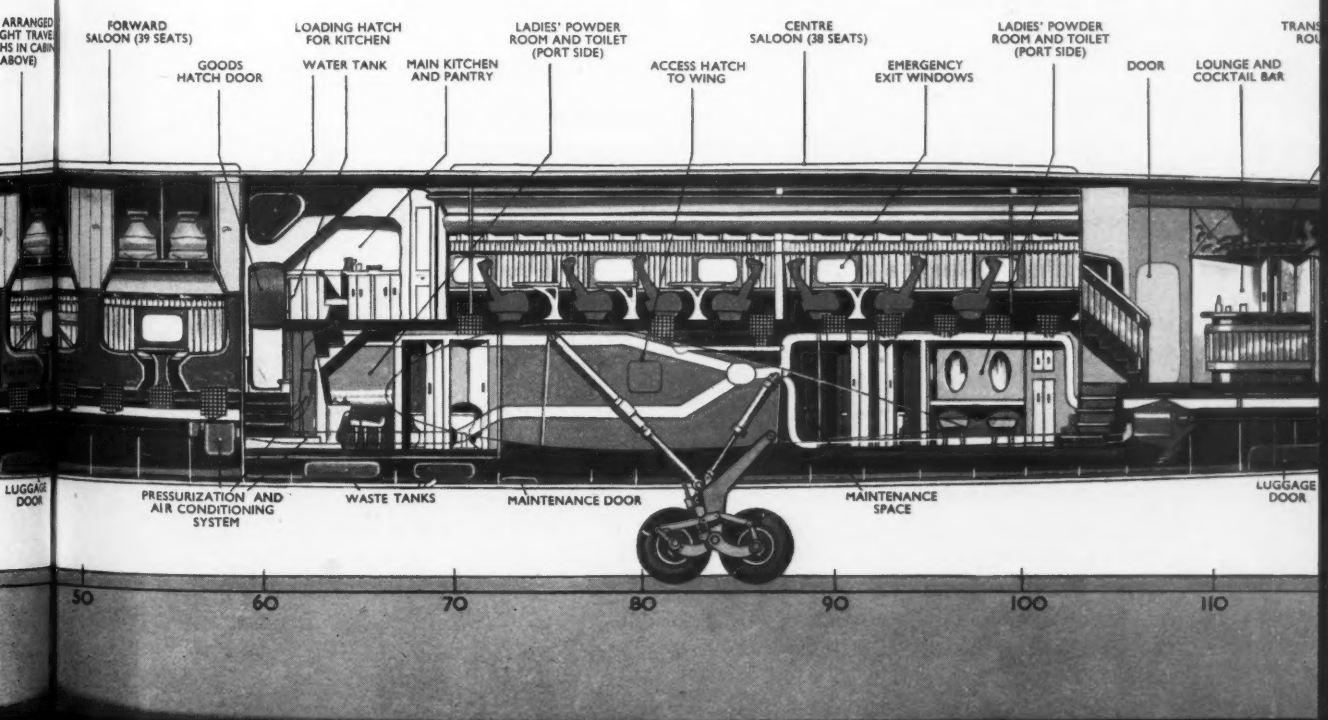
approximately double the size of the Avro Lincoln bomber, the largest aircraft at present serving with the R.A.F., and in weight is equivalent to more than three fully laden Lincolns.

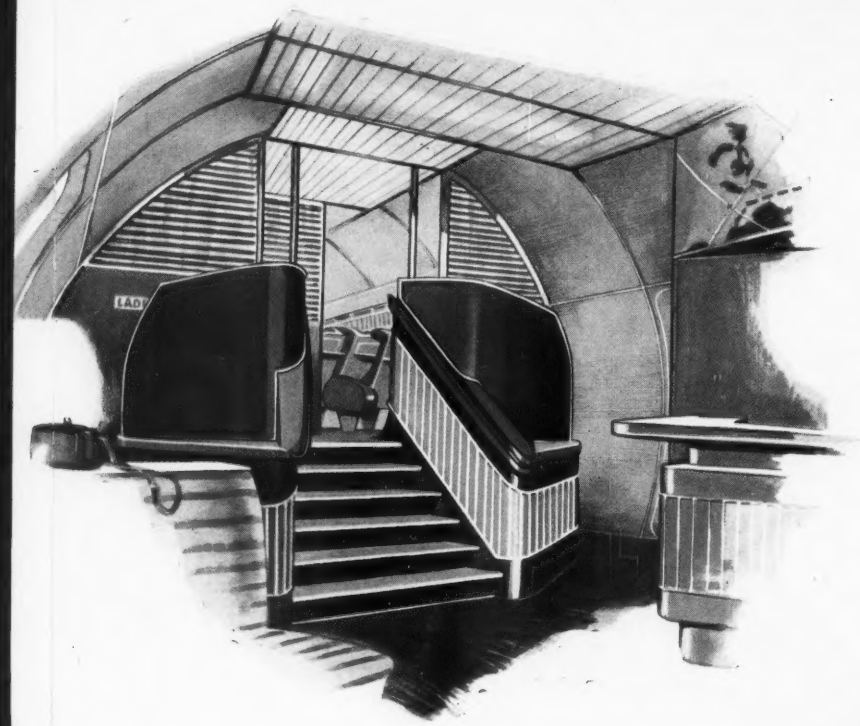
Located at low-mid position, the wing is built in three sections: the 100-ft centre-section—or inner wing as it is known in the Bristol works—which extends completely through the fuselage, and two 65-ft outer wings. The maximum depth of the inner wing is 6 ft 6 in; thus, power plant inspection is possible during flight, though this will not normally be undertaken. Housed between the wing spars and ribs, outboard of the engines, are twenty-eight flexible-bag fuel tanks with a total capacity of 13,650 gal.

The major portion of the 177-ft-long fuselage is in the form of a pressure hull, in which an equivalent cabin altitude of 8,000 ft is maintained while flying at 25,000 ft; it is humidified and air-conditioned to allow maximum comfort under all flight conditions, and although an internal pressure difference of 5½ lb/sq in causes an increase of only half an inch in length and a quarter in diameter, the effect of extremes of temperature (between minus 60 deg. C. and plus 40 deg. C.) is a lengthwise expansion of no less than 4½ in. Leakage equivalent to one square inch is permitted over the whole fuselage.

The eight Bristol Centaurus 20 sleeve-valve radial engines, each rated at 2,500 h.p. for take-off, are housed in the inner wing forward of the front spar, and are completely enclosed. They drive counter-rotating, co-axial Rotol airscrews, wooden bladed, and having a diameter of 16 ft. Electrical synchronizers control the speeds of all eight airscrews, as selected by the engineer.

Though the first flight occurred as recently as September 4th, and the Brabazon has yet to prove itself, it can be said that many new problems and difficulties, common to all large aircraft, have been met and surmounted.

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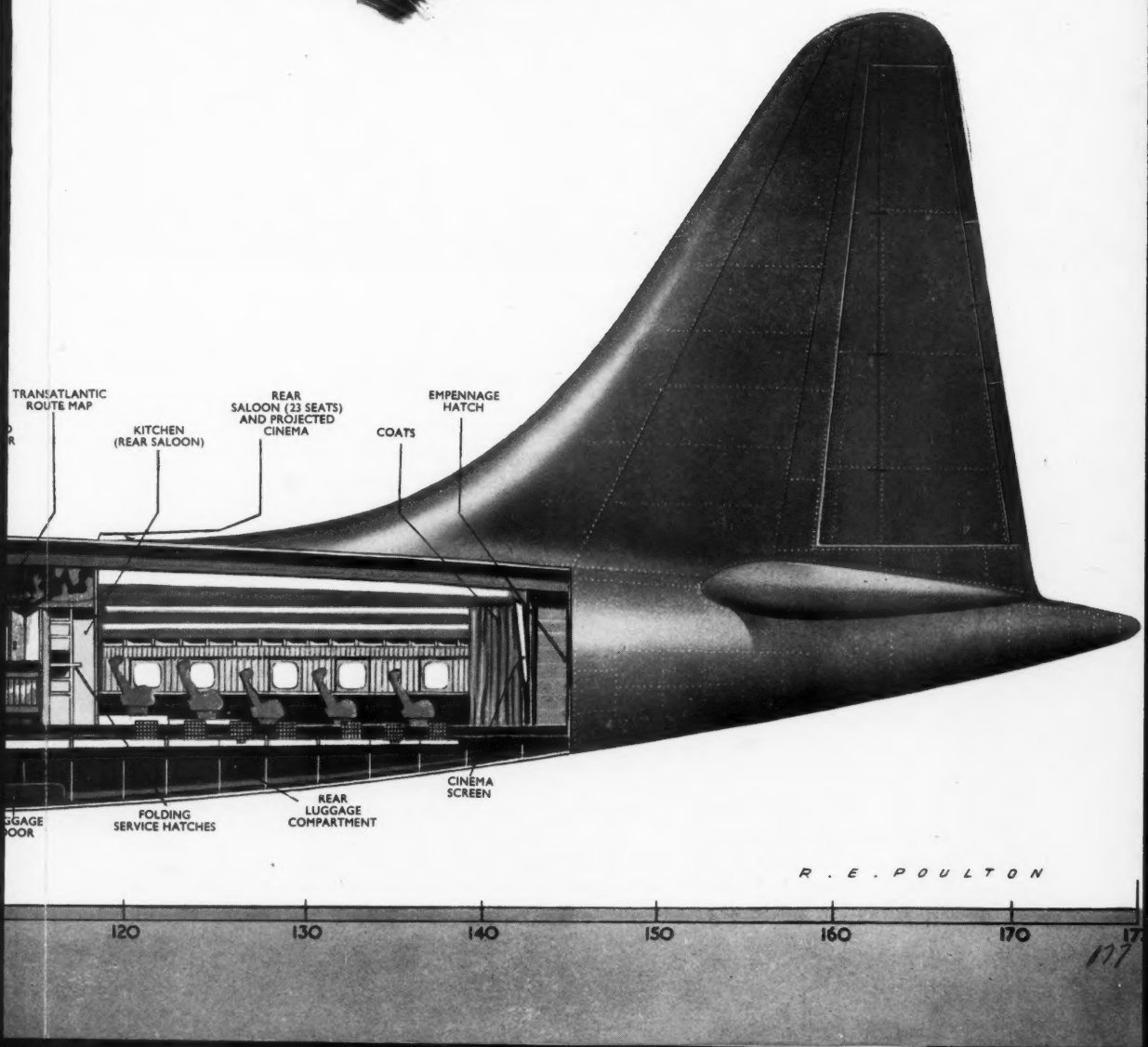
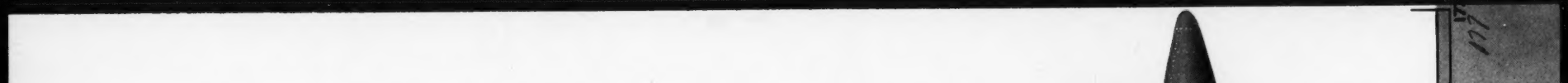
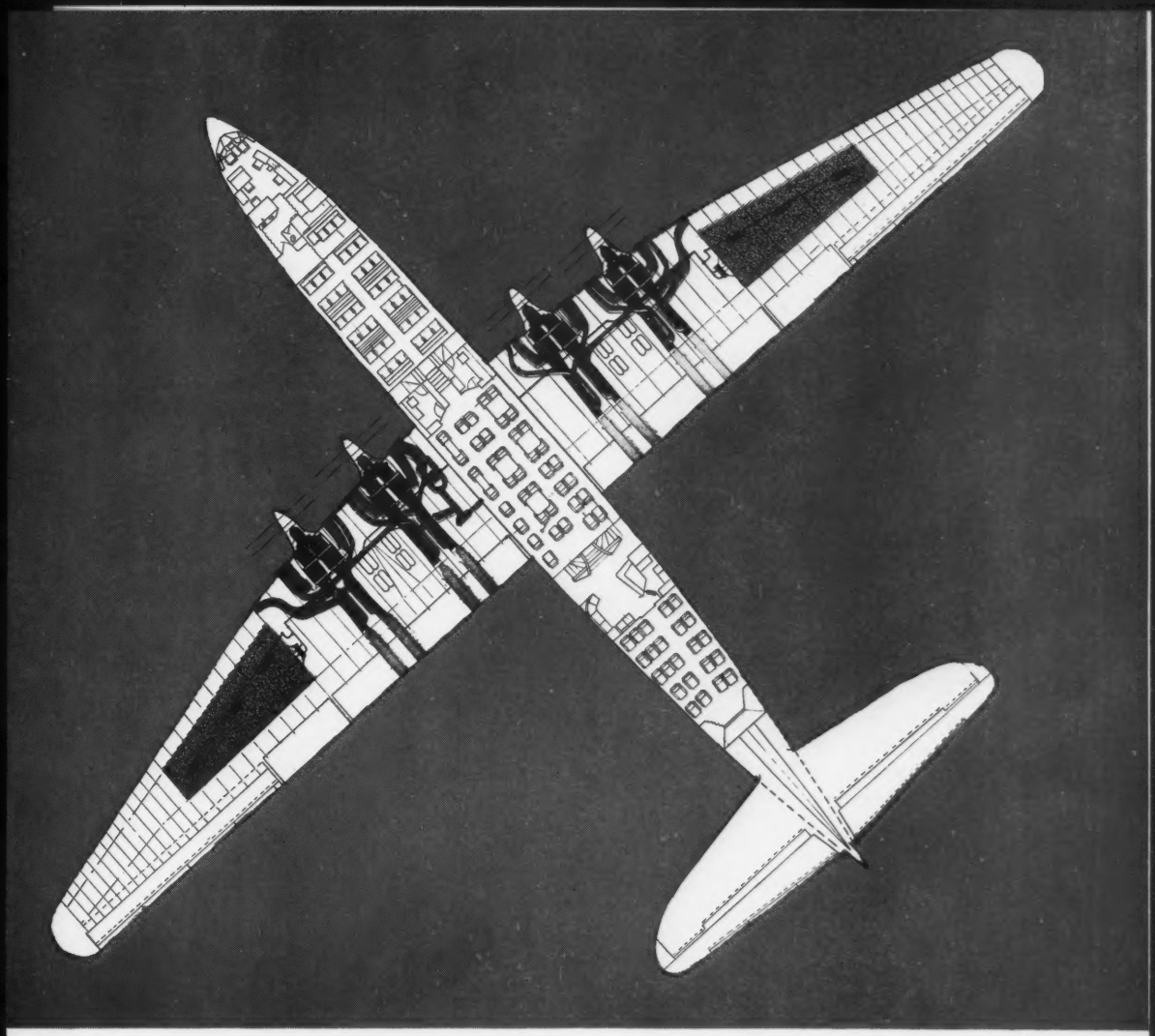

TRANSATLANTIC ROUTE MAP
KITCHEN (REAR SALOON)
REAR SALOON (23 SEATS) AND PROJECTED CINEMA
COATS
EMPENNAGE HATCH
CINEMA SCREEN
REAR LUGGAGE COMPARTMENT
FOLDING SERVICE HATCHES
R . E . POULTON
120
130
140
150
160
170





Brabazon II Characteristics

SOME time in 1951 the Mk. II Brabazon should be completed, and will display numerous divergences from Mk. I practice. The characteristic nose of the Mk. I will have given way to a more conventional formation, occasioned by the collision-warning radar installed in the extreme tip of the fuselage, and a modified windscreen. There will be no astrodome, and windows, floors, loading hatches and emergency exits will be re-positioned and augmented in conformity with B.O.A.C. requirements. Due to the installation of large spring tabs, the horn-balanced rudder and elevator will be of new configuration. The faired fuel sumps will have vanished and eight jet pipes will emerge from the trailing edge. Forward of the power plants the leading edge will be extended and the intakes for the eight paired Proteus turbojets will be shallower than those for the piston engines. The co-axial airscrews will each have four blades.

Great weight-savings will be effected in the wing and fuselage structure and, at B.O.A.C's request, the top deck will be extended further aft.

To reduce the severity of load effects on runways the Mk. II will have two main undercarriage groups of 4-wheel bogies, with Dunlop twin-tyred wheels. The new undercarriage may enable the type to be operated from fourteen of the twenty-three airfields on the North Atlantic and Empire routes. Of the remainder, five are scheduled for improvement to Brabazon standards within a few years.

Brabazon II data follow: Span, 230 ft 0 in; length, 178 ft 10 in; height, 50 ft 8 in; wing area, 5,422 sq ft; equipped weight, 163,000 lb; gross weight, 290,000 lb; cruising speed, 330 m.p.h. at 35,000 ft; operating ceiling, 40,000 ft; range, 5,460 miles at 330 m.p.h. at 35,000 ft.

BRABAZON

(BRISTOL 167 MARK 1)

MAIN DIMENSIONS

Span	230 ft 0 in
Length	177 ft 0 in
Height	50 ft 0 in
Undercarriage wheelbase	64 ft 0 in
Undercarriage track	55 ft 0 in

FUSELAGE CAPACITY

25,000 cu ft

WING

Wing area (gross)	5,317 sq ft
Aspect ratio	10
Maximum depth	6 ft 6 in
Aerofoil section (laminar flow)	Root T.P.4 (mod.) Tip T.P.5
Root chord (centre-line of fuselage, leading edge and trailing edge produced)	31 ft 0 in
Tip chord	10 ft
Thickness/chord ratio (root)	0·21
Thickness/chord ratio (tip)	0·15
Dihedral (outer plane)	2 deg.
Incidence	+3 deg. 30 min.
Sweepback of leading edge (inner wing)	4 deg. 16 min.
Sweepback of leading edge (outer wing)	14 deg. 56 min.
Taper ratio $\left\{\frac{\text{tip chord}}{\text{root chord}}\right\}$	0·32

WEIGHTS

Gross weight	290,000 lb
Operational weight (weight less fuel and payload)	169,500 lb
Maximum landing weight	240,000 lb
Weight for first flight	200,000 lb

LOADINGS

Wing loading	50·4 lb/sq ft
Power loading	14·5 lb/sq ft

ACCOMMODATION

Crew of 6-12 and 100 passengers (maximum)

ENGINES

Number—8

Type—Bristol Centaurus 20 eighteen-cylinder, sleeve-valve, air-cooled, arrangement in pairs in inner wing, driving independent co-axial counter-rotating airscrews

Capacity—3,270 cu in (53·6 litres)

Take-off output—2,500 h.p.

Maximum continuous power ("M" blower)—2,190 h.p. at 5,000 ft

Maximum weak-mixture cruising power ("S" blower)—1,640 h.p. at 22,000 ft

Maximum climbing power—2,190 h.p. at 5,000 ft

TAILPLANE

Span	75 ft 0 in
Tailplane and elevator area (gross)	1,103 sq ft
Tailplane and elevator aspect ratio	5
Tailplane dihedral	0 deg.
Tailplane incidence	+2 deg.

FIN AND RUDDER

Total area (including dorsal fin)	692 sq ft
Aspect ratio	1·3
Rudder range	25 deg. port 25 deg. starboard

ELEVATOR

Total area	264 sq ft
Range up	25 deg. 0 min.
Range down	15 deg. 0 min.

AILERONS

Span (each)	43 ft
Area (each)	185 sq ft
Range up	20 deg. 0 min.
Range down	20 deg. 0 min.

FLAPS

Total area	682 sq ft
Settings : Full	50 deg. 0 min.
Take-off	20 deg. 0 min.
Approach	50 deg. 0 min.

AIRSCREWS

8 Rotol constant-speed, fully feathering and reversing

Number of blades	3 per airscrew
Operation	Hydro-electric
Diameter	16 ft 0 in
Pitch range (fine)	Front, 16 deg. Rear, 14 deg. 30 min.
Pitch setting (feathered)	Front, 84 deg. 30 min. Rear, 84 deg. 30 min.
Reverse	Front, minus 18 deg. 5 min. Rear, minus 16 deg. 40 min.

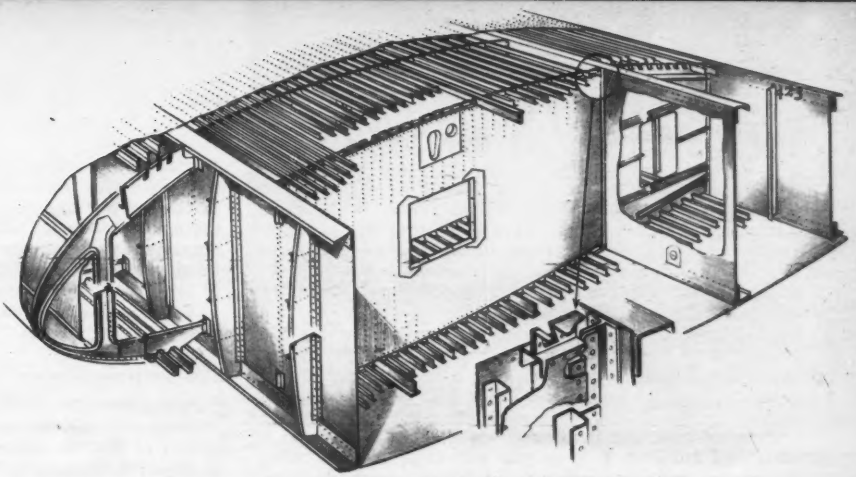
FUEL AND OIL CAPACITIES

Fuel (each wing)	6,750 usable, 78 unusable
Fuel capacity (total)	13,650 gal
Number of fuel tanks	28
Oil capacity (total)	450 gal

PERFORMANCE (*ESTIMATED*)

Cruising speed	250 m.p.h. at 25,000 ft
Maximum speed	300 m.p.h. at 25,000 ft
Rate of climb at sea level	750 ft/min.
Service ceiling	25,000 ft (increasing as fuel is consumed)
Range	5,460 miles at 250 m.p.h. at 25,000 ft

THE STORY OF THE BRABAZON . . .



Outer wing structure at tank emplacement, showing leading-edge details, reinforcing longerons of the tank cells, the rear tank spar, and the rear spar proper.

picks up with the rear spar of the inner wing and extends to the full span.

Just as the quality of skinning and the close tolerance of the skin panel thickness concerns the fuselage, so does it also apply to the skin plating of the wings. For similar reasons of stress/weight factors, skin thickness is graded spanwise and chordwise, the heaviest gauge being employed around the centre-ection, each panel outboard being reduced in gauge.

The centre-section is plated with sheet 0.185in thick, successive outboard skins being respectively 0.176in, 0.166in, 0.144in and 0.125in thick. At the outer end of the wing the final three panels are 0.125in thick, attached to the front spar, 0.095in, attached to the rear spar, with a centre panel 0.116in thick. These thicknesses apply to the upper surface, but in general the same graduations hold good for the lower surfaces, except that the panels are, mostly, a gauge below their counterpart on the top surface; however, compensating this are extensive reinforcing skins around the undercarriage bays.

SYSTEMS, SERVICES and EQUIPMENT

Undercarriage

AS originally planned, the Brabazon undercarriage embodied two main assemblies, outboard of the engines. In 1944, for structural reasons, a third leg was added under the fuselage in addition to the nosewheels; but nearly two years later (November, 1945) it was decided that the track of 94ft would limit the operation of the aircraft from runways and taxi tracks and the main legs were therefore moved inwards to reduce the tack to 55ft. At the same time the central set of wheels was abandoned. These alterations necessitated considerable redesign of the wing and fuselage structure, but as this coincided with the decision to fit Proteus turboprops in the second and subsequent aircraft, it was possible to take both factors into account simultaneously. The Brabazon I is, nevertheless, carrying a considerable amount of unnecessary weight in fuselage structure, a legacy of the under-fuselage undercarriage assembly.

At present the principal units of the undercarriage are two main Dowty assemblies with liquid-sprung shock-absorber units and two twin-tyre Dunlop wheels; a Dowty nosewheel assembly, also liquid-sprung, with twin steerable Dunlop wheels; and a non-retractable tail bumper in the form of a skid, again with liquid springing. The main wheels measure 63in x 35½in and have a 90 lb/sq in tyre pressure; they are reinforced with rayon cord and retract forwards into the wing. The nosewheels retract rearwards. The Dunlop Company has calculated that the heat generated in slowing down the Brabazon's weight, when landing at anything between 100 and 125 m.p.h., is 69,500 B.Th.U. —sufficient to raise 4½ cwt of steel to blood-red heat. It is absorbed and dissipated by the brakes in less than a quarter of a minute.

For the Dunlop electro-pneumatic brake system there are 16 main air bottles and four emergency bottles. Air is fed to the brakes through differential and relay valves which can be operated by either pilot.

Hydraulics

The main wing hydraulic system operates the following wing services: (1) flaps; (2) fire and cooling flaps; (3) main undercarriage (opening and closing doors, and lowering and retracting wheels). There are four sources of power supply: two engine-driven pumps, ground connections, a hand pump and an emergency hand pump. Each of the eight flap sections is moved by a separate double-acting jack mounted within the wing. Normally all flap-operating valves are synchronized, but arrangements have been made whereby on the early flights any one flap section can be raised or lowered independently, e.g., in the event of tail buffeting.

The system for the nosewheel is used to steer while taxying, and to raise, close and open the doors. The pilot controls a steering motor and has a master switch for unlocking the undercarriage control lever, which is operated by the first engineer and raises and lowers the nosewheel and main wheels simultaneously. Nosewheel steering is by two double-acting, spring-loaded hydraulic jacks, the springs of which centralize the wheels on retraction.

Electrical

The main electrical installation on the Brabazon I is 208 V 3-phase, 400-cycle A.C., with generation by six Rotax 30 kVA engine-driven alternators, each of which supplies a section of the total load. About 20 per cent of the output of each alternator is transformed and rectified to cater for 28.5 V D.C. applications on the aircraft. In the low-voltage D.C. circuits are two separate banks of Exide batteries, each of four 12 V units coupled in series parallel, providing a total capacity of 240 ampere-hours at 24 volts nominal. The total weight of the batteries is 384 lb.

In an emergency, the batteries are capable of giving a total output of 300 amperes for 23 min continuous, or 1,000 amperes for 3½ min continuous.

Fuel System

With weight-saving in view fuel tanks integral with the wing structure were originally planned for the Brabazon, but experience was limited and development difficulties proved so formidable that in April, 1946, the decision was taken to change to the flexible-bag type, in the Mk. I aircraft at least. Experiments with integral tanks nevertheless continued with a view to their use in the Brabazon II.

The present Mk. I aircraft has two sets of fourteen tanks (by Fireproof Tanks, Ltd.), with a total capacity of 13,650

THE STORY OF THE BRABAZON . . .

gallons, of which 13,500 gallons is usable. These tanks are disposed between the spars and ribs. At the front and rear of each are branch pipes which feed into two main trunk lines supplying electrical fuel pumps in a collector box faired in beneath each wing. In emergency, or if the collector boxes require servicing, electrically operated cut-off cocks can be used to isolate the boxes from the fuel bags. These cocks are shut electrically, in the event of a crash, by the action of inertia switches. From the collector boxes fuel is pumped through non-return valves and a control cock in the main supply line, from which each engine is fed.

Pressure-refuelling is effected via a valve at the rear of each fuel collector box on the underside of each wing. Intercomm. sockets at these points allow verbal communication with the cabin.

Fuel for the anti-icing heaters is delivered by a pump in each of the starboard under-wing gravity-fed collector boxes, from which the two main fuel pumps distribute to the engines. On the port side the system is extended to supply the three cabin heaters. Each anti-icing heater consumes 5 gal/hr. The fuel system for the tail anti-icing heaters is entirely self-contained.

Power-operated Controls

"Although there have been exponents of aerodynamic balancing (of controls) for the largest aeroplanes envisaged, I believe that the uncertainty of over-balance or under-balance on the first flight alone demands the use of power operation." These are the words of Mr. A. E. Russell, in his revealing lecture, *Some Engineering Problems of Large Aircraft*, delivered before the Royal Aeronautical Society in 1946; and it is now of interest to observe that, although the flying controls of the Brabazon I are power-operated, these will be abandoned on the Mk. II in favour of spring-tab operation.

In the early days of Brabazon development an electro-hydraulic system of control was chosen but was rejected in 1947 in favour of a purely hydraulic scheme of much simpler layout. As alternatives, an electrical system and a second type of hydraulic system were developed simultaneously. To simulate the loads on each of the control surfaces and undercarriage, ground rigs were constructed, and for over two years development was in progress with these trial assemblies to produce the most efficient system of hydraulically powered actuators. During August, 1948, after many hours of durability tests on the ground, air-testing was sanctioned and a Brabazon-type hydraulic elevator-operating unit was installed in a Lancaster. Before flight-clearance was given for the complete Brabazon system the elevator unit underwent fifty hours' air-testing, and during this period each of the hydraulic units for the other controls was being subjected to a 500-hour actuation and durability test.

The hydraulic system for the Brabazon's power-operated controls is separate from other hydraulic services, and comprises a power supply (from twenty engine-driven Lockheed pumps, five on each auxiliary gear box) and four power units, for each aileron, the rudder and the elevator. Each operating system is divided into two half-systems as below:

(1) Ailerons: Four half-systems (2,000 lb/sq in) with 12 pumps (three to each half-system).
(2) Elevator: Two half-systems (1,900 lb/sq in) with four pumps.
(3) Rudder: Two half-systems (1,900 lb/sq in) with four pumps.

Except for details all four main units are similar: the movements of the pilot's controls are conveyed by rods to "follow-up" mechanisms in the appropriate hydraulic units, and thence to rotary control valves, which bring jacks into action to move the control surfaces. As the surfaces move into position the follow-up mechanisms return the rotary control valves to their central position; thus the pilot's controls and the control surfaces are synchronized. Should a rotary control valve jam, movement of the follow-up mechanism turns a transfer valve, so reducing pressure in the supply line to a by-pass valve and, by allowing this valve to open, shortening the supplies from the rotating control valve to the jack. The jack is rendered useless by this automatic operation and the other half-unit is free to operate.

A spring device is incorporated in the control system to simulate aerodynamic "feel."

Test Instrumentation

Every hour the Brabazon I is in the air will yield its measure of technical experience, and with such a complexity of systems and services involved it is not surprising to discover that more than half the fuselage is occupied by approximately a thousand instrument dials (including oscillographs), many made at the Royal Aircraft Establishment, Farnborough. All readings will be recorded photographically or plotted automatically for analysis in Bristol's flight-research laboratory; thus valuable time will be saved in the checking of performance (jointly with the Aeroplane and Armament Experimental Establishment, Boscombe Down), in completing and refining design, and in accelerating production of the Mk II aircraft.

The test instruments used are mainly of synchronous electrical type, each with a transmitter containing an element sensitive to the quantity to be measured and with means of electrically repeating the indications of these elements to dials in the cabin. In order that each group of dials shall give a complete picture of some function or aspect of performance without the need for cross-reference, the dials are grouped in twelve panels, relating to the following: (1) aircraft performance (i.e., speed, height, rate of climb, etc.); (2) performance of essential services (i.e., hydraulic systems—excluding the power-operated flying controls—and the fundamentals of the electrical system; (3) operation of powered flying controls; (4) engine cooling; (5) engine temperatures; (6) engine oil temperatures; (7) airscrews; (8) oil temperatures in the hydraulic systems; (9) output, etc., of the electric generating system; (10) pressurization; (11) anti-icing (including external skin temperatures); (12) aerodynamic pressures and flows.

Two types of camera are used. For panels where readings remain approximately constant with a given flight condition, the periodicity of photographic record varies from one picture every ten minutes to one every other second and a negative size of 5in × 5in (sufficient to cover 170 dials) has been adopted. Where the rate of indication change is greater (e.g., in the aircraft's response to control movements) the photographic periodicity may be as high as four per second. Specially built 35mm cinematograph cameras meet this requirement.

The twelve cameras are controlled from a master station on the flight deck, where the chief test engineer is stationed, but observers can immediately override the master control should they notice any trend or condition which, in their opinion, should be recorded. Normally, however, all cameras operate simultaneously to obtain a full record of performance under selected conditions.

Two mirror-galvanometer oscillographs, each capable of showing 15 quantities simultaneously, record low-frequency vibrations of up to 60 cyc/sec (such as those caused by aerodynamic forces) and steady strains in the structure. High-frequency vibrations, up to 1,000 cyc/sec (e.g., those caused by engine forces) are recorded by cathode-ray oscillographs reading from four stations at one time.

A continuous watch on the operation of various emergency devices is maintained by three "lamp recorders," each containing 120 lamps. Should any lamp light up, it will produce a line on a slow-moving film, thus recording the timing and duration of the associated operation.

Special test-requirements are inevitable during the Brabazon trials, and to meet them, various portable and self-recording instruments are provided. In conjunction with two double-beam cathode-ray oscillographs they enable any flight phenomena to be observed.

If it is borne in mind that up to 100 hours' laboratory work will be entailed for every hour of flight testing, the duration of the ground tests which preceded the first flight —and during which the instrumentation was being adjusted —is readily accounted for. The reward for the elaborate instrumentation described should be a mass of unique technical records of immense significance.

Radio and Intercommunication

For early flight trails the Brabazon I has V.H.F. and M.F. W/T communications equipment, Marconi automatic direction-finding, Gee, and a radio altimeter. All flight crew stations have facilities for any three receivers and any two transmitters, together with intercomm.

There are three separate intercomm. channels, with no fewer than 49 points; any two or all three channels can be mixed, or, as for the first flight, all three can be fed together to the flight deck. Availability of three channels means that the flight observers can conduct three separate tests simultaneously without cross-talk on one channel interfering with conversations on the other two or the flight deck. The chief observer is stationed at the navigator's position and controls channel mixing and selection.

Pressurization and Air-conditioning

The 143ft pressure-hull section of the Brabazon I extends between pressure diaphragms at frame F.1029, forming the front wall of the cockpit, and R.680, aft of the passenger compartment. In the Brabazon I the maximum differential pressure is 5.5 lb/sq in and the cabin altitude-equivalent at 25,000ft is 8,000ft. The decision to power the Brabazon II with Proteus turboprops, with a consequent increase in cruising height from 25,000ft to some 35,000ft, has necessitated the development of centrifugal blowers capable of producing a higher differential pressure than those for the Mk. I.

As might be imagined, the expansion of the fuselage under pressure presented formidable problems, and although under normal conditions the internal pressure difference causes an increase of only ¼in in length and ¼in in diameter, the effect of extremes of temperature (between minus 60 deg C and plus 40 deg C) is a length-wide expansion of fully 4¼in. One square inch of leakage area over the whole fuselage is permitted.

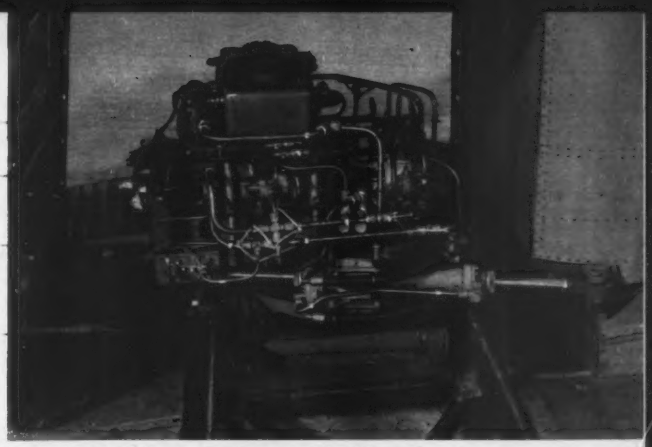
The principal components of the air-conditioning and pressurization system are two Marshall blowers, two coolers, three heaters, three discharge valves, four inward relief valves, a safety valve, re-circulating fans and booster fans.

Air circulates from the aft hold, through a heater, for distribution through ducts to the cabins. Thence it is extracted through grilles in the floor and returned to the aft hold. To keep the air fresh about 25 per cent new air is added every cycle; this is collected by wing-root intakes and is fed into a mixing box with the recirculating air from the aft hold, before passing through a heater for ducting to the cabins. Though a small amount of air is continuously escaping through joints in the fuselage plating, most of the air to be displaced to make way for new air leaves the fuselage through reducing valves. These valves prevent differential pressure from building up dangerously (e.g., as in a dive). Should cold air be required, the heater is switched off and coolers in the supply system from the wing-root ducts are brought in.

In the event of failure of the two Marshall blowers, direct ventilation is obtained by opening spill-valves on the main leading-edge intakes for the pressurizing system.

Air entering the pressurization intakes is filtered and passed to the blowers (driven by the inboard accessory gear boxes), which force air on to the cold air mixing boxes of two heaters. Vibrations set up in the air intakes are damped out by passing the air through silencers mounted in series, one in each wing, and one in the fuselage. The air passed through the blowers having been compressed and heated, it is ducted to cooler units in each wing. Mass-flow units are provided to measure the flow of air. Flow is controlled by spill valves on the intake which, when opened, allow air to escape into the wings.

Twenty oxygen cylinders are provided for emergency use.



Hydraulical unit for power operation of rudder.

Gust Alleviation

To relieve the wing loads sustained in gusty weather a "gust alleviator" was considered desirable, and is but one of numerous novelties first developed for the Brabazon. Various suggestions received careful attention before a promising method—precursor to that now fitted to the Mk. I—was evolved. It has been estimated that without the alleviator the weight of the Mk. I wing would have been increased by about 7,000 lb, and that of the Mk. II by 13,000 lb. In collaboration with the R.A.E., a Lancaster has been fitted experimentally with a Brabazon-type alleviator.

The pitot of the alleviator is mounted in the extreme nose of the fuselage and produces a differential pressure on a diaphragm with change of vertical component of wind. The deflection of the diaphragm operates the aileron power-control units through an electrical circuit, which causes the ailerons to be deflected simultaneously in proportion to gust intensity, thus reducing sudden variations in wing loading.

Fire Precautions

The automatic fire-extinguishing system provides protection for the port and starboard wing anti-icing heaters, tail anti-icing heaters, cabin conditioning heaters, each engine and its air intakes, the forward and aft luggage holds and the electrical distribution centre. There are four banks of eight extinguishers for the engines alone, two in each bank having dual heads for "second shot" operation on either engine of a pair. In addition to the fifty automatic units, hand-operated extinguishers are strategically placed.

Anti-icing

Thermal anti-icing systems serve the mainplanes, tail-plane and fin. Two Radiation heaters are fitted in each inner wing, just outboard of Nos. 1 and 8 engines, and each pair is fed with air from an aperture which derives its supply from the outboard engine air intake. Each aperture has an inlet flap, operated by a hydraulic jack, electrically controlled from the engine fire panel, and by closing the flaps each heater system can be isolated in the event of fire. Being normally open, the flap ventilates the wing interior in the region of the fuel bags. From the heaters, air is ducted along the leading edge to the double skin of the outer wings. The tail anti-icing system, with heaters, is self-contained.

The "birdproof" windscreen, comprising several layers of different types of glass and a Perspex panel ¼in thick, is demisted by hot-air circulation. Although controls for airscrew anti-icing are fitted at the 2nd engineer's station, the present wooden airscrews do not have the necessary equipment.

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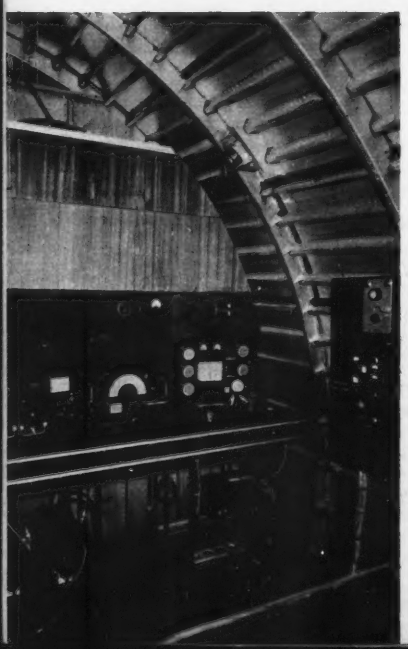
NAVIGATOR'S STATION

Situated aft of the captain's seat, the navigator faces forward. He has a chart table, drawers and cupboards for instruments and books, a switch for the Gee set, air-mileage indicator, repeater unit for the air-position indicator, A.S.I., sensitive altimeter, 24-hr clock, air thermometer, radio altimeter, compass master indicator switch for A.P.I. transmission, A.P.I., signal pistol and inverted P.12 magnetic compass. (See view below.)

PILOTS' STATION

It will be gathered from the general view of the Brabazon I cockpit (right) that the captain and co-pilot have relatively few instruments under their surveillance. The seats and the port control column have been removed for clarity. The "birdproof" windscreen has hot-air demisting.

Navigator's Station.



RADIO OPERATOR'S STATION

This is on the port side of the flight deck, to the rear of the navigator's station. The radio operator sits facing aft. Little equipment is needed for early flight trials.

Pilots' Station.

DASHBOARD PORT PANEL (CAPTAIN): Radio altimeter limit indicating lamps (white light = above height; green light = desired height; red light = below height); radio altimeter (gives true height); air-speed indicator (operated by pitot protruding from port side of fuselage); undercarriage warning lamp (red) (light goes on and buzzer sounds when engines are throttled back whilst undercarriage is up); button for testing undercarriage warning system; oxygen bayonet-fitting.

DASHBOARD INSTRUMENT-FLYING PANEL (two installed): altimeter (pressurized, 0—45,000ft); artificial-horizon indicator; air-speed indicator (50—350 knots, operated from pitot in nose); rate-of-climb indicator (registers climb or descent up to 2,000ft/min); G.3 Gyro compass; turn-and-slip indicator.

DASHBOARD CENTRE PANEL: Flap-position indicator; time-of-flight clock D/F. visual indicator; air thermometer; barometer (absolute pressure); control panel (G.M. compass).

DASHBOARD STARBOARD PANEL (CO-PILOT): Oxygen bayonet-fitting; cabin pressure-height indicator (0—30,000ft).

OTHER CONTROLS AND INSTRUMENTS (either at top or bottom of dashboard): Control-surface-locks warning lamp; ice-detector warning lamp; voice-and-range filter; intercommunication station box (captain and co-pilot); undercarriage buzzer; rudder-pedals adjustment; controls-locking handle.

PORT SIDE (CAPTAIN): Cupboard; dimmer switch for side-panel lamps; dimmer switch for pedestal lamps; altitude limit switch, 50—300ft; inboard and outboard pressure-head heating switches; windscreen de-icing switch; windscreen wiper control and switch; lighting switch; dimmer switch (dashboard ultra-violet lamps); dimmer switch

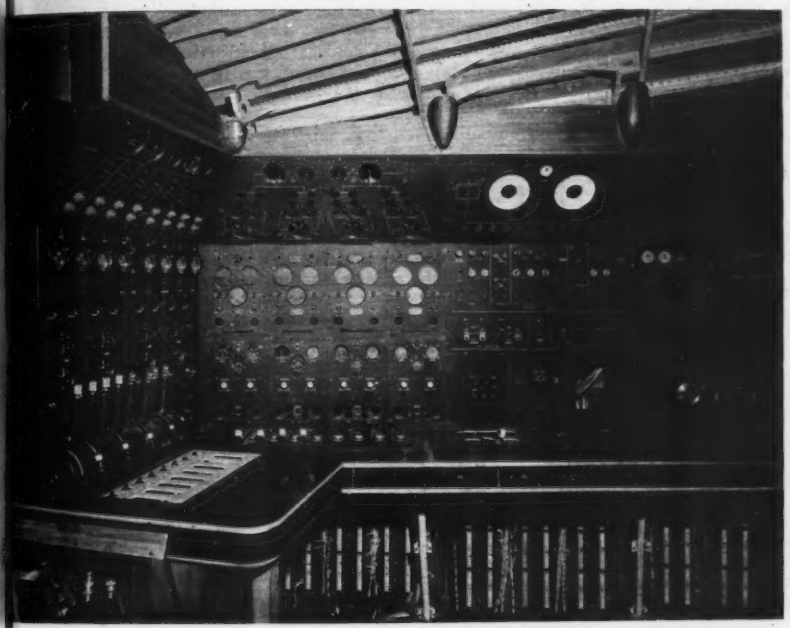
(dashboard red lamps); intercomm. change-over switch; auto-pilot controller; V.H.F. controller; beam-approach remote control; auto-pilot switch and indicator unit; auto-pilot on/off switch; nose-wheel steering control; intercomm. socket.

STARBOARD SIDE (CO-PILOT): Intercomm. socket; auto-pilot controller; identification-lamps signalling switch; gust-detector-head heating switch; taxying-lamps switches; navigation-lamps switch; windscreen-wiper switch; windscreen wiper control; lighting switch; dimmer switch (roof-panel lamps); dimmer switch (side-panel lamps); dimmer switch (dashboard red lamps); dimmer switch (dashboard ultra-violet lamps); cupboard; stowing bracket.

PEDESTAL: Flap selector lever; No. 1 and 2 throttle lever (yellow); No. 3 and 4 throttle lever (yellow); No. 5 and 6 throttle lever (green); No. 7 and 8 throttle lever (green); throttle locking lever; airscrew-reverse lock; airscrew-reverse master switch; aileron, elevator, and rudder trimming handwheels and indicators; landing-lamp switches; master ignition switch; boost gauges (four fitted).

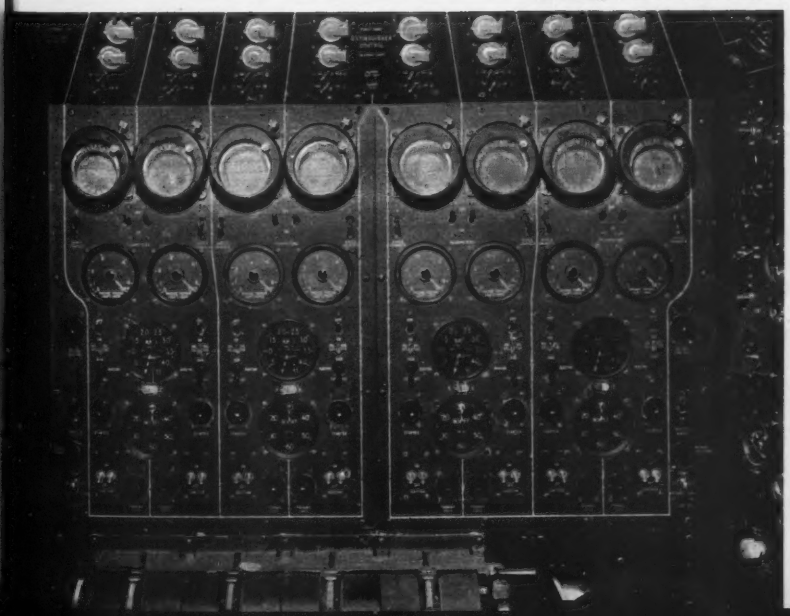
CONTROL COLUMNS AND SUBSIDIARY CONTROLS: Captain's and co-pilot's control columns; press-to-transmit button; elevator inboard tab switch; autopilot cut-out button; master control switch; controls-locking handle; rudder-pedals adjustment handle; control-surfaces locking indicator lamps (red) (four fitted); rudder and brake pedals (two sets).

ROOF PANEL: Undercarriage-position indicator; undercarriage master switch; wheel-brake indicator lamps; brakes push button; aileron-raising and lowering buttons; ailerons position indicators; ailerons gust-relief switch; ailerons gust-relief indicator lamp (white) (light shows that gust is encountered and immediately it goes out the appropriate relief push button is operated to correct position of ailerons); rudder-position indicator; elevators position indicator; undercarriage emergency retraction switch. (In case of a baulked take-off or possible ground collision this enables the pilots to raise the undercarriage without reference to the engineers in the compartment aft. Operation is electro-hydraulic.



Engineers' Station.

First Engineer's Power Panels.



ENGINEERS' STATION

The engineers are positioned on the starboard side of the flight deck, aft of the pilots' station. Both have swivel seats. The first engineer's controls are forward and outboard, and those of the second engineer outboard and aft.

FIRST ENGINEER: When facing forward the first engineer has in front of him the port and starboard power panels and airscrew synchronizing panel. Above the power panels is the engine fire panel, which also includes flight instruments that are visible to both engineers. Below the power panel, but on the table, are the throttle controls.

When facing outboard the first engineer has in front of him, from top to bottom, the port and starboard oil-system panels, four engine-temperature panels, and four dual-reduction-gearbox and airscrew-control panels. Below the latter, but on the table, are airscrew and speed controls and, to the right of these, the undercarriage control panel.

SECOND ENGINEER: When facing outboard the second engineer has in front of him the following panels: Fuel, anti-icing, power-operated controls, intercomm., brakes and oxygen, humidity, air heaters and flow control, and cabin-pressure control. His table incorporates the flap-control panel and control-surfaces locking lamp.

When facing aft the second engineer has in front of him the following panels: At top general fire panel; at centre, electrical, port and starboard alternators and forward and aft D.C.; at bottom, flight instruments supply, crew station lights, and instructions for electrical operations. On the floor is a hydraulic hand pump for control surfaces locking.

(*N.B.*—Both engineers, the navigator and the wireless operator have swivelling seats with Dunlopillo cushioning, and levers for height adjustment and position in azimuth.)

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POWER PLANT AND AIRSCREWS

THE eight individual Centaurus 20 engines of the Brabazon I are housed within the wing and are angularly disposed, one to the other, so that their crankshaft centre-lines intersect at a vertex angle of 64 deg. The crankshafts drive torsion shafts, which, in turn, drive bevel pinions meshing with bevel wheels carried on the respective airscrew shafts. These latter are nested coaxially, the outer shaft carrying and driving the rear airscrew and the inner shaft similarly serving the front airscrew. Thus, the Brabazon has *coaxial* airscrews, entirely separate in operation, and *not*, as is often asserted, a "contraprop" arrangement, which description connotes a single airscrew unit of two blade-banks.

Before the power plant installation is described in some detail, it may be noted that the Centaurus 20 is an 18-cylinder sleeve-valve, air-cooled unit, generally similar to the Centaurus 18 as installed in the Hawker Sea Fury, but having no built-on reduction gear and being provided with special side-mounting lugs and throttle butterflies oil-heated against icing. Hobson injection carburettors and two-speed superchargers are fitted. Leading particulars are:—

Capacity, 3,270 cu in (53.6 litres); bore, 5.75in; stroke, 7.00in; take-off power, 2,470 h.p.; max. normal continuous power ("M" blower), 2,160 h.p. at 5,000ft; max. weak mixture cruising power ("S" blower), 1,600 h.p. at 22,000ft; max. climbing power, 2,160 h.p. at 5,000ft.

There were three phases of power-plant ground-testing. The first concerned the vibration testing of the airscrew shafts and stalks and employed dummy airscrews and electric motors to simulate the engines. Stage 2 involved a rig with two Centaurus engines geared together in order to test the gear box and adjacently mounted engines. For Phase 3 a complete replica of the power plants was made, embodying accessories, and mounted in a section of the wing. Ground tests, closely simulating flight, were thus made possible.

The power-plant arrangement already outlined was adopted after every alternative had been investigated. Involving, as it does, the use of but a single pair of gears (the reduction bevels) for each engine/airscrew drive, the lowest possible transmission loss penalty is incurred. The "target" mechanical efficiency laid down was the inordinately high one of 99.3 per cent, and the Engine Division of the Bristol Aeroplane Company has the satisfaction of having proved that the efficiency drop is actually less than that estimated in assessing the target figure.

Nested snugly in the wing, one of the Centaurus 20 sleeve-valve radials, of 2,500 take-off horse power, is exposed for inspection. The engine cowling proper has spark plug inspection panels.

In order to obviate any adverse effects of primary-drive-shaft mis-alignment, both engines, with their dual reduction gear box, are carried by a central box structure forming a cantilever projecting forward from the wing spar. The upper and lower surfaces are portions of the wing skin. Each engine is attached to the box structure by means of tubular mountings in the form of twin tripods, which pick up the engine crankcase at their feet and have their apices secured near the top and bottom of the box member by quickly detachable fittings. The tripods take care of all vertical loads and torque reaction, and in order to stabilize the assembly and to look after fore and aft accelerations, two additional tubes are provided, connecting top and bottom of the engine assembly to a common point towards the front of the box structure.

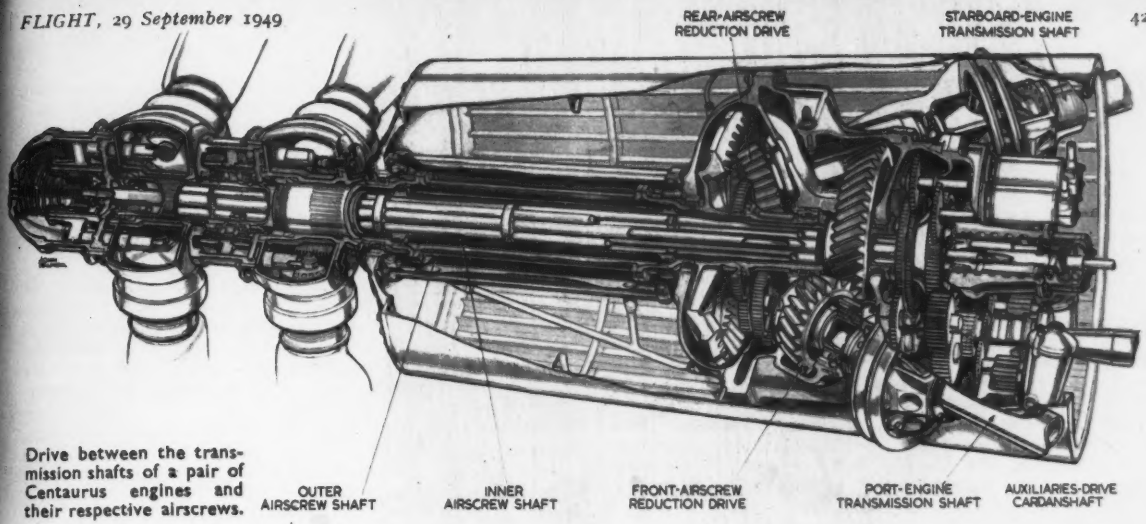
The exhaust is directed rearwards through shrouded individual pipes which join in pairs to the bifurcated exhaust manifold. Two tapering curved units make up the manifold and carry short discharge elbows at their lower extremities; the shroud is divided into sections, each with a separate cooling air intake and multiple discharge orifices. After leaving the manifold, the exhaust gas stream is encased in a "sleeve" of relatively cool air, whereby the heating effect on the wing or undercarriage, e.g., at take-off, is reduced.

In common with all marks of the Centaurus engine, the cylinders and heads are closely baffled to ensure optimum cooling under all conditions of flight. Surrounding the cylinders is an abbreviated cowl of approximately cylindrical form; to facilitate spark plug inspection this is provided with small access panels immediately over the cylinder heads.

The rear end of the cowl assembly is in flexible contact with a diaphragm surrounding the engine and dividing the engine cell into two zones; the forward zone is in full ram-air pressure which is not only used for engine cooling but which also feeds the main engine air intakes. In addition, a duct conveys air from this region to the oil coolers behind the front spar.

After cooling the engine, the warm air in the region behind the diaphragm is discharged through controllable cooling flaps in the upper and lower wing skins. Under normal flight conditions, the upper flap remains closed, thus maintaining drag at an absolute minimum, while the lower flap is adjustable in order to control the degree of cooling.

The power from each engine is transmitted through a tubular drive shaft to the dual reduction gear. At the rear end, the drive shaft is bolted to the engine crankshaft flange through a flexible coupling consisting of a light-alloy ring carrying a number of rubber trunnions. The flexibility of the trunnions is sufficient to accommodate any slight deviation from true alignment which might be encountered. At its forward end the shaft is united to the input flange of the dual reduction gear by a universal joint, equipped with non-metallic pre-loaded bearings.



Drive between the transmission shafts of a pair of Centaurus engines and their respective airscrews.

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Means are provided for measuring the engine torque by electrically determining the degree of torsion in the primary drive shaft tube. For this purpose, two toothed inductor rings encircle the universal joint; one of these is carried directly by the forward end of the drive shaft tube and the other is supported on a spider member, deriving its location from the engine end of the drive shaft. Associated with the inductor rings is a double "generator," in which electrical impulses are induced. Phase differences between the impulses of the two portions of the generator provide an indication of true engine torque.

Two complete and independent reduction gears are incorporated in the magnesium-alloy casing, with means of driving the aircraft accessories and a simple system of lubrication and cooling, both of which function whether either or both the engines are running. The reduction ratio is 0.400.

The right-hand power input shaft carries at its forward extremity a straight-tooth bevel pinion, the teeth of which mesh with the ground teeth of an internal bevel gear. This gear is serrated to the large-diameter tubular shaft, carried on ball and roller bearings in the magnesium casing; which drives the rear of the coaxial airscrews. The shaft is made up of three sections, flange-bolted together. Nesting within it, and running in a series of ball and roller bearings, is the inner airscrew shaft, carrying at its forward extremity the forward airscrew and at its rear extremity the main driving bevel wheel. In mesh with the teeth of this wheel are the teeth of the left-hand input bevel pinion.

Notwithstanding the high efficiency of the gear trains, considerable heat is generated at the actual tooth-contact point, so to maintain a satisfactory temperature level, oil jets impinge upon the tooth flanks as they come out of mesh. Oil draining away is cooled and recirculated.

Accessory Drives

There are two subsidiary gear trains in the gear box. The first of these picks up the drive from the outer airscrew shaft and conveys this through idler gears and a shaft to a free-wheel unit and thence to the aircraft accessory drive shaft; the second train picks up a drive from the inner airscrew shaft and similarly conveys this to the same accessory drive shaft. This shaft carries a small gear which drives the main oil-pressure and scavenge pumps. If either engine is closed down, the section of the free-wheel unit associated with the drive from that engine commences to slip, or "free-wheel," the other engine carrying on with the drive. With both engines running, notwithstanding that their speeds are nominally synchronized, there will inevitably be minor speed fluctuations between the two drives to the free-wheel unit. In order to avoid any possibility of resulting shock-loading, the drive ratios have been carefully selected so that under synchronized conditions the entire accessory load is carried by the right-hand engine. Meanwhile, that portion of the free-wheel unit associated with the left-hand engine "free-wheels" at a very low speed difference.

The ancillaries serving the coaxial airscrews are located on the rear cover of the dual reduction gear unit. These consist of the airscrew controller units and the synchronizing alternators. Drives for these units are tapped off the gear trains which drive the free-wheel units.

Lubrication of the working parts is by a supply of cool oil pumped to vital points by a gear type pressure pump; this pump also supplies the oil necessary for hydraulic airscrew operation, a filter being interposed in the circuit to exclude any small particles of matter from the constant speed control mechanism.

Feathering

During single-engine operation, the non-operative airscrew is, of course, feathered. If the front airscrew only is feathered, the aerodynamic forces acting on the blades do not produce any airscrew turning moment. In the case of a feathered rear airscrew, however, the blade angle for minimum drag is such that a reverse airscrew-rotating moment is produced. Since this is undesirable, means are provided inside the dual reduction gear to prevent it. Carried on the forward face of the internal bevel gear is a large ratchet wheel. Three pawl units equally spaced round this wheel, but attached to the front cover of the gear box, are brought into action automatically by the airscrew feathering oil supply. The pawls "click" over the ratchet wheel teeth while the latter is rotating in a forward direction with the rear airscrew. As the feathering process is completed, the airscrew slows down and comes to a standstill before the reverse torque builds up. At this point the teeth of the ratchet wheel are brought into abutment with the pawls, thus preventing reverse rotation. In normal operation an arrangement of springs completely retracts each pawl. As a means of precluding excessive torques in the reverse direction, e.g., in the event of a backfire, the ratchet wheel mounting incorporates a high-torque slipping clutch.

Three entirely independent oil systems supply respectively, the left hand and right hand engines and the dual reduction gear and each consists of an oil cooler and a service oil tank. As already intimated, air to the oil coolers is ducted from the forward portion of each engine cell; the ducts run straight to the twin oil coolers which discharge their air through variable-area shutters into the main wing space. The reduction gear cooler is jointly fed by small ducts from both the main cooler ducts. This also discharges into the wing space. Air outlets from the wing space are provided through the rear spar and upper wing skin, near the trailing edge. Oil consumption is made good by maintaining a constant level in the service

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tanks, make-up oil being supplied from a common pressurized storage tank within the wing.

Complete fire-indicating and fire-extinguishing equipment is built into the power plant. At critical points on each engine, and attached to the fireproof walls of the engine cell, are a series of flame-detecting switches, electrically connected to fire-warning indicators at the 1st engineer's station. Should fire break out, the engineer will be immediately warned. He will first close the cooling-air shutters, turn off fuel and oil, close down the engine, feather the airscrew, and then put the fire extinguisher system into operation. The system consists of a series of rings encircling the forward and aft portions of the engine; through these a methyl/bromide fire extinguishing medium is forced and, being sprayed from numerous small holes in the rings, should completely smother any fire. In addition, supplies of methyl/bromide are taken to the exhaust manifold and to the engine air-intakes, thus ensuring that combustion within the engine ceases immediately.

In order to prevent any possibility of flames from an engine cell penetrating to the wing space behind the spar, shutters are provided at the entry to the oil-cooler air ducts.

The aircraft services are operated both electrically and hydraulically, and are maintained by pumps and alternators driven by the main engines. These are grouped around the accessory gear box, which, in turn, is securely bolted to the "floor" of the wing space between the two spars. Lubrication of this gear box is self-contained, a sump of moderate capacity and a pump being provided.

The drive to the gear box is by means of high-speed shafts connecting with the accessory drive output shaft at the dual reduction gear. This shaft is in two main sections, each about 5ft 6in long, united by a short intermediate shaft. At each end of both sections of the shaft are flexible joints.

[*A note on the Proteus turboprop installation for the Brabazon II will be found on page* 416.]

Airscrews

The eight Rotol wooden airscrews are special three-bladed, hydraulic, constant-speed, feathering and braking units of 16ft diameter. All are similar except that the operating cylinder for the front unit is not made in annular form. Engine/airscrew control embraces synchronous control of the engines in addition to the control of airscrew pitch for constant-speeding, feathering and braking functions. The system is based on the selection of one engine as a "master," the remaining engines being subject to automatic continuous correction to the governing r.p.m. of the master. Left-hand engines of each pair are arranged as masters, but only one unit is employed as such at any one time. The rotors of the corrector motors are joined by worm gears and mechanical linkage to the constant-speed mechanisms within the controller unit. One winding of each corrector is taken to its own engine's alternator, the other winding being connnected to the alternator of the master engine. Each corrector is, in fact, an electric differential which, when all engines are in phase, will not turn; but when a speed difference does exist, it will rotate at a speed proportional to the difference and in a direction determined by whether its engine is over-speeding or under-speeding relative to the master.

The braking operation of the airscrews is not completed until the undercarriage wheels are settled on the ground, with the forward speed of the aircraft at not more than 120 m.p.h. Immediately prior to touch-down the captain sets the throttle levers to "SR" (slow running ahead). As the aircraft touches down he operates the master switch and unlocks the airscrew reversing lock, and then moves the throttle levers through to minimum braking (slow-running reverse) position. This operates a switch which energizes a braking solenoid in the airscrew system. Next a pause of a few seconds is allowed before opening up the engines to give the required degree of braking.

A weight-sensitive switch on the port main undercarriage leg allows the circuit to be alive only when the port wheel is on the ground. This weight-sensitive switch also indicates by a lamp to the captain that the aircraft is airborne.

PRODUCTION

THE tooling of an aircraft as large as the Brabazon has its own special problems, particularly when manufacture is virtually on prototype scale only. Some degree of tooling is essential and it must necessarily be extensive because of the size of the structure—and for this very reason, any over-elaboration of tooling would incur a correspondingly severe penalty in cost.

The main component consists of the complete fuselage, 177ft in length, with the centre section (or inner wing) of the mainplane and the tailplane. The outer portions of the mainplane are built as separate components. As a result of experience gained in building a full-scale fuselage-nose test-section, a design of assembly fixture was evolved consisting of a series of posts arranged in rows of four across the line of the fuselage at every fourth frame station. Along the fuselage the posts were connected by longitudinal members. On the two outside lines of these posts were mounted arches, which carried brackets at the top to locate the central top longeron of the fuselage.

Wooden cradles in three sections, shaped to the contour of the fuselage, were carried between the four posts in each transverse row, or between the longitudinal members that connected them. By taking out their single-bolt attachments, each cradle could be dropped clear for the removal of the completed assembly. Brackets were also mounted on the stanchions or longitudinal members to carry locations for the frames.

The first stage in the assembly of the fuselage was the mounting of the frames on the fixture, and longerons and stringers were next placed in position. Vertical alignment of the frames was effected by plumbing down to stations marked out on the temporary floor. The floor was also used in the assembly of the main top longeron, the sections of which were first lifted into an approximate position and held temporarily by clamps at the tops of the supporting arches. Jacks standing on the temporary floor were then placed beneath the longeron to support its weight from below and give control of height adjustment.

In order to avoid excess weight, the thickness of sheet for the skin was controlled to special tolerances in manufacture. With the exception of the panels of the parallel centre portion of the fuselage, which is 25ft in length, all the skin sections required shaping to compound curvature. Because of the small quantity required, this operation was carried out by wheeling. Over the upper half of the fuselage the application of the skin was comparatively easy and, in applying the skin to the underside, use was made of the fixture cradles to support the panels. Vertical edges of the fuselage skin plating were butt-jointed and longitudinal joints lapped downwards. All skin joints were assembled dry without any protective treatment between the surfaces in order to obtain closer joints and a better surface for the sealing compound. As a result of the pressure tests with the full-scale nose section, countersunk-head type rivets were considered to be unsatisfactory and, in the actual prototype, therefore, mushroom-head rivets were used. It was found that variation occurred in the diameter of commercially supplied mushroom-head rivets, and in order to avoid the need for special manufacturing tolerances, a system of graded diameters of standard rivets was adopted.

Special problems also arose in the actual forming of the head as rivets up to $\frac{1}{4}$in are used in the fuselage and up to $\frac{3}{8}$in in diameter in the wing. Extensive tests were made to establish the optimum length of rivet stem needed to form a satisfactory head. All these problems were investigated and a chart was issued for the guidance of the shops. Sealing was effected by spraying all joint interior surfaces with Peratol rubber-base solution.

The centre section or inner wing of the Brabazon extends completely through the fuselage. Although erected at a later stage than the part used for the fuselage, the inner wing-assembly fixture is really an integral part of the main assembly structure and to some extent follows the same principle as the fuselage portion. It consists of a triple row of posts, between which are carried wooden cradle-supports for the under-surface skin. The two outer rows of posts are much taller than the centre row and carry location brackets for the top and bottom booms of the two spars. The upper portion of these two rows of posts are hinged to the lower portions and were designed to be lowered on to shorter posts to serve as assembly platforms for the leading and trailing edge portions of the wing.

Sliding pick-up points were arranged at the outboard ends of the inner wing assembly fixture to permit the structure to expand. This precaution was very necessary as the dimensional variation caused by temperature could be as much as 0.2in over the inner wing span of 100ft.

Assembly of the inner wing began with the laying of the bottom-surface skins on the cradles of the fixture. After this the spars were lifted into position, clamped to the location brackets and engaged at the outboard ends with the sliding pick-ups already mentioned. Next the interspar ribs were installed and then the stringers of both top and bottom surfaces were run through the cut-outs in the rib-booms.

In the centre portion some inner-wing skin panels measure 16ft by 6ft and have a thickness of 0.185in. As with the fuselage skin the sheet was rolled to special thickness tolerances. Flush riveting is used on the wing and a slightly domed rivet head was selected to avoid marking the skin during riveting. Lengths of protrusion were also specified as a result of experiment to give satisfactory results. The requirements laid down necessitated special machining of all the rivets.

Aft of the pressurized portion, the fuselage is known as the rear body. Both rear body and tailplane are built in extensions of the main assembly fixture. The portion for the assembly of the rear body is comparable with that for the pressurized portion, except that there is no necessity for the arches to locate the main top longeron which ends at the rear pressure bulkhead.

Similarly, the tailplane assembly-fixture bears a strong resemblance to that of the inner wing, except that it is necessarily erected at a much greater height. Three lines of posts support cradles for the undersurface skin and the upper portions of both outer lines can be lowered as in the inner wing fixture to serve as assembly platforms at a later stage. The actual procedure of assembly followed generally the same sequence as that of the inner wing.

Both outer wings were built as separate components in fixtures closely resembling those of the inner wing. They were also built in the horizontal or flight position in order to simplify problems of handling and removal. All spars are built as separate sub-assemblies and the assembly of the outer-wing tructure was closely similar to that of the inner portion.

Constructional details of the fin are very similar to those of the tailplane. It is a two-spar unit and has a height of some 36ft above the fuselage datum. The building of this unit followed the well-established procedure of the other components, except that in this case the assembly fixture was of the vertical type and of L-form, with spar-root locations carried on the vertical column and rudder-hinge locations on the horizontal base. The steep slope of the fin leading edge is blended into the top of the fuselage by the wider sweep of the dorsal fin. This unit, which was also built as a separate sub-assembly, weighs 196lb and was the first to be assembled to the fuselage. The fin proper weighs about ¼ ton and in the assembly position its tip was some 50ft above the ground. For hoisting it into the flight position, it was necessary to fit an extension-jib to the Coles crane used for the operation, to give a maximum clearance of 53ft from ground-level to hook.

The rudder, built under sub-contract by Folland Aircraft, Ltd., weighs 441 lb and was similarly hoisted into position by the same crane. Lifting fittings were built into the structure, in positions so calculated in relation to the centre of gravity, that when freely suspended from the crane hook, the rudder took up true flight position. Platforms at six levels were erected round the rear end of the fuselage for tail-unit assembly.

In order to permit inspection of the rudder and fin to be carried out in the open without rigid scaffolding, a cage or lift, large enough to hold two men, was designed for suspension from the hook of the specially extended Coles crane. It is prevented from swinging, as the result of wind-pressure or manœuvring of the crane, by vertical guide rails consisting of tubes 30ft 6in in length, suspended from the crane jib and braced to it at the bottom by horizontal struts. Telephone intercommunication is provided between lift and ground.

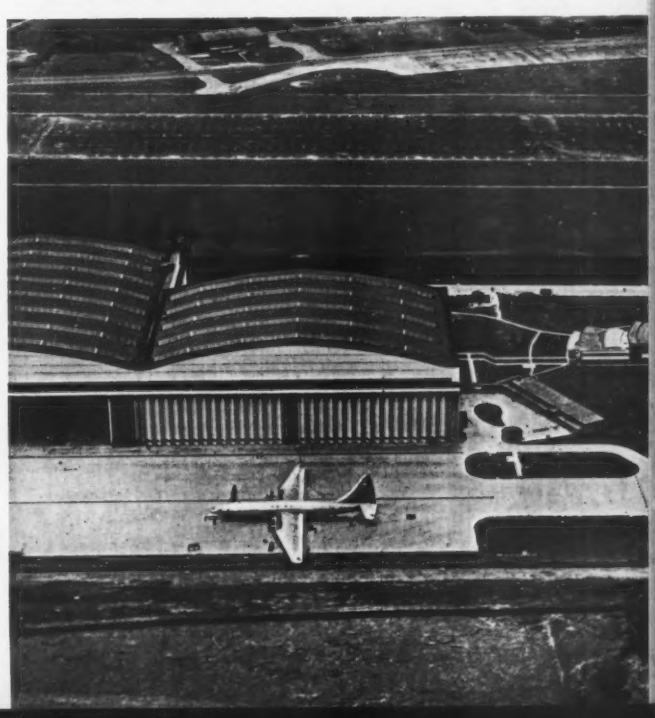
ASSEMBLY HALL AND RUNWAY

THE dimensions of the Brabazon I and production and servicing requirements of the Brabazon II conditioned the design of the Filton assembly hall. This hall is 1,052ft wide, has a full centre bay 410ft deep, and side bays 260ft deep. Measured to the roof apex, the height is 117ft. The floor area is nearly eight acres, and fronting the hall is 6½ acres of apron. The three bays open on to this apron through full-width sliding and folding aluminium-alloy doors, motor operated. Facing the doors at the north side of each bay is a double glazed wall 50ft high and with a combined length of 1,000ft. Apart from serving as an insulating blanket, this combines with other lighting to give daylight working conditions, with a concomitant advantage of saving in electricity consumption during daylight working hours.

The architect responsible for the design of the hall was Eric Ross, A.R.I.B.A., with D. du R. Aberdeen and P. N. Taylor as planning and design assistants; the consulting engineers were Brian H. Colquhoun and Partners, and the principal contractors were Sir Robert McAlpine & Sons.

The 2,750-yd-long, 100-yd-wide, east-west runway, construction of which entailed the partial demolition of the village of Charlton, was mainly the work of John Laing & Son, Ltd. It is an extension of an earlier runway, 1,500 yds long and 50 yds wide.

Items on the bill—the "Brab.", the hall and the runway.



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HIGH DUTY ALLOYS, LTD.—Gear box front cover.
STERLING METALS, LTD. — Cylinder heads; gear box casing.

Bronze

BOLTON AND SONS, LTD., THOS. — Housings.
LANGLEY ALLOYS, LTD.—Housings.
STONE AND CO., LTD., J.—Housings.
YORKSHIRE ENGINEERING SUPPLIES, LTD.—Bushes.

Suppliers of Bar Material

BOOTH AND CO., LTD., JAMES.—Aluminium-alloy bar.
BROWN, BAILEYS STEEL WORKS, LTD. —Alloy steel bar.
CLYDE ALLOY STEEL CO., LTD.—Alloy steel bar.
ENGLISH STEEL CORPORATION, LTD. — Alloy steel bar.
FIRTH AND J. BROWN, LTD., THOS.—Alloy steel bar.
GOVAN SHAFTING AND ENGINEERING CO., LTD.—Non-alloy steel bar.
I.C.I. METALS, LTD. — Aluminium-alloy bar.
LEE AND SONS, LTD., A.—Non-alloy steel bar.
NORTHERN ALUMINIUM CO., LTD. — Aluminium-alloy bar.
T.I. ALUMINIUM CO., LTD. — Aluminium-alloy bar.

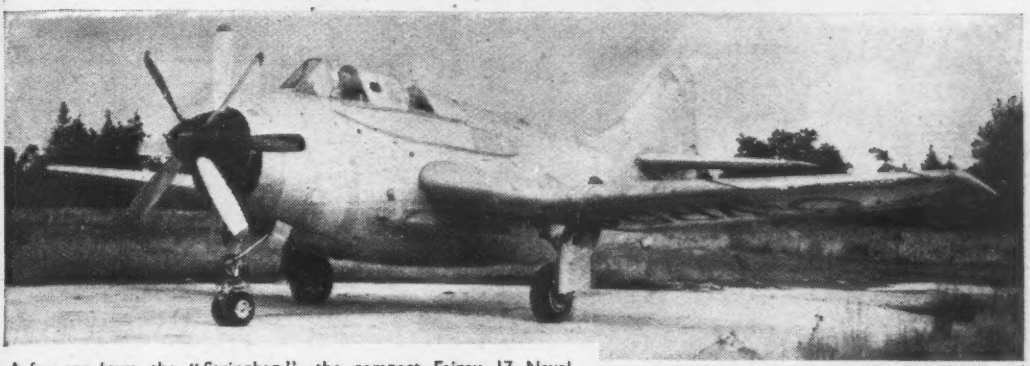
Various Accessories

BRITISH THOMSON HOUSTON CO., LTD.—Magnetos and couplings.
DUNLOP RUBBER CO., LTD. — Flexible pipes.
EVERSHED AND VIGNOLES, LTD.—Airscrew and throttle control units.
HEPWORTH AND GRANDAGE, LTD. — Piston rings, etc.
HOBSON, LTD., H. M.—Injectors.
HOYT METAL CO., LTD.—White metal for bearings, etc.
LAYCOCK ENGINEERING CO., LTD. — Trunnion ring units and accessory drive shafts.
LODGE PLUGS, LTD.—Sparking plugs.
MARCONI WIRELESS TELEGRAPH CO., LTD.—Harness.
PLESSEY CO., LTD.—Fuel pumps.
RANSOME AND MARLES BEARING CO., LTD.—Bearings.
VOKES, LTD.—Fuel filters.
WELLWORTHY PISTON RINGS, LTD. — Piston rings, etc.

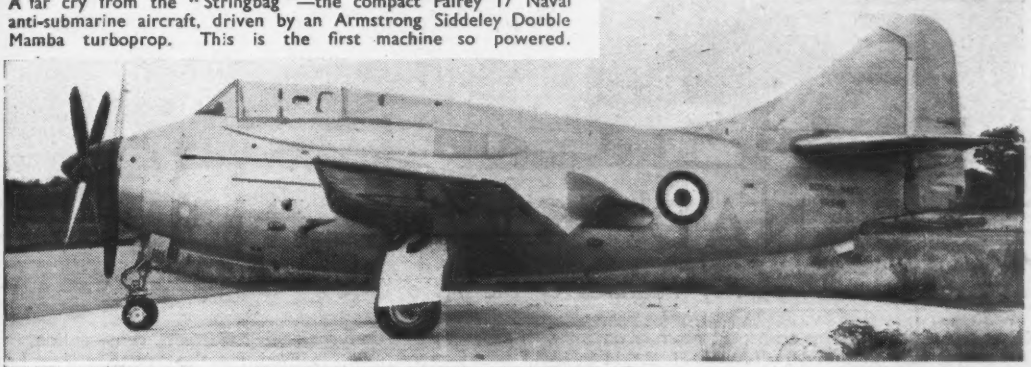
Small Items

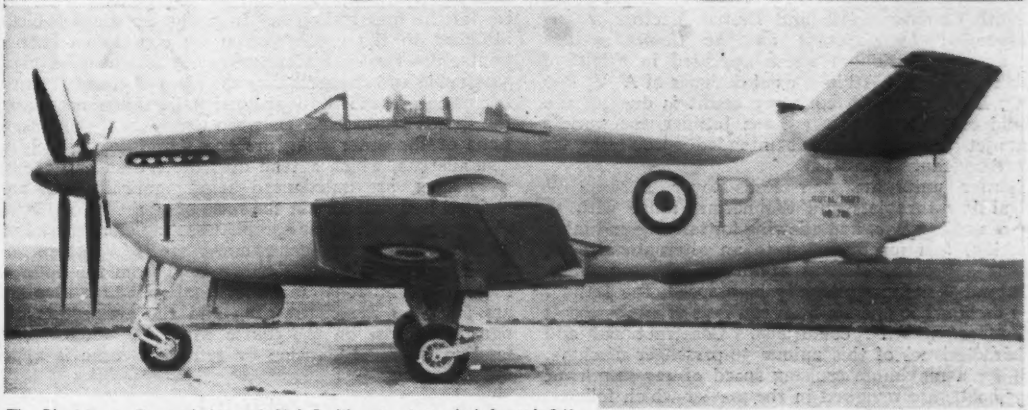
ACCLES & POLLOCK, LTD.—Steel tubes.
ANGUS & CO., LTD., GEO.—Oil seals.
AUTOMOTIVE ENGINEERING CO., LTD. —Seegar circlips.
"AIPITE" PRODUCTS, LTD. — Paper fibre joints.
AUTOMOTIVE PRODUCTS, LTD.—Filters.
BRITISH BELTING AND ASBESTOS, LTD. —Clutch linings.
BRITISH ERMETO CORPORATION, LTD.—Union fittings.
COOPERS MECHANICAL JOINTS, LTD. — Strainer units; laminated brass shims and washers.
DIAMOND SCREW AND COTTER CO., LTD.—Taper pins.
FENNER, LTD.—Cheney hose clips.
GUEST, KEEN AND NETTLEFOLDS, LTD. —Aerotight nuts.
HARVEY, LTD., G. A.—Strainer units.
HALL AND HALL, LTD. — Laminated brass shims and washers.
INDIA RUBBER GUTTA PERCHA & TELEGRAPH CO., LTD.—Oil retainers.
KLINGER, LTD., R.—Joint washers.
MILLS, LTD., J.—Woodruffe keys.
MANGANESE BRONZE AND BRASS CO., LTD.—Oilite bushes.
SPENCER MOULTON AND CO., LTD., GEO.—Rubber joint rings.
SALTER AND CO., LTD., GEO.—Springs.
SMALL AND PARKES, LTD. — Cotton webbing strips.
STANDARD INSULATORS, LTD. — Hose clips.
TERRY AND SONS, LTD., H.—Springs.
TURNER, LTD., J. H.—Springs.
TELEFLEX, LTD.—Control units.
WELLWORTHY PISTON RING CO., LTD. —Circlips and retaining rings.
WILD, LTD., W. J.—Steel washers.

ANTI-SUBMARINE



A far cry from the "Stringbag"—the compact Fairey 17 Naval anti-submarine aircraft, driven by an Armstrong Siddeley Double Mamba turboprop. This is the first machine so powered.





The Blackburn General Aircraft Y.A.5, likewise intended for "A-S" duties, but temporarily powered with a Rolls Royce Griffon. Like the Fairey machine, this type has been designed for a turboprop.

CANADA'S JETLINER

Key Features of the Avro C-102

THE case for the pure-jet transport aircraft on inter-city routes was presented by Mr. E. H. Atkin in his British Commonwealth and Empire Lecture, *Inter-City Transport Development on the Commonwealth Routes*, an appreciation of which appeared in *Flight* of September 22nd. Mr. Atkin is chief designer of A. V. Roe (Canada), Ltd., to which company credit is due for the design and construction of the C-102 Jetliner, the world's first pure-jet transport aircraft intended specifically for short/medium-range operation.

The power units are four Rolls-Royce Derwent V centrifugal-flow turbojets and the normal range with 50 passengers and baggage, and allowing for taxying and take-off, stacking, fuel for diversion to an alternate airfield, instrument approach, etc., is approximately 500 miles. Notwithstanding its exceptionally high speed, the Jetliner has been designed to operate from runways of 4,000-5,000ft length, under I.C.A.N. conditions. Constructional and other characteristics of this unique 50-passenger machine, designed for a maximum cruising speed of 427 m.p.h. at 30,000-35,000ft, are reviewed in the matter which follows.

Of circular cross-section, the fuselage measures 10ft in diameter and comprises four main components—nose, centre-section (including the centre wing), rear centre-section, and rear section (including the lower fin). In order to achieve the highest strength in the former rings, the stringers are external to the outside former-flanges, thus avoiding the need for cut-outs. The forward pressure-bulkhead is immediately ahead of the main instrument panel and isolates the nosewheel compartment from the pressurized region; the rear pressure-bulkhead is clamped between the angles of the after transport-joint. There are four escape-hatches in the cabin and one in the flight deck. The windscreen structure is an aluminium-alloy casting, with three centre panels of special sandwich construction, incorporating electrical de-icing; a vinyl interlayer ensures retention of pressure in the cabin in the event of windscreen damage. The two direct-vision windows and two after windows are of Plexiglass. Pressure-sealed entrance doors are located in the port fuselage-side at each end of the main cabin, and an additional door can be provided on the starboard side for the rear baggage compartment.

The mainplane is built in three sections and has detachable tips. Conventional two-spar construction, with heavy-gauge skin, is used for the centre-section, which carries the four turbojets. In the outer wings, which are attached to the centre-section by continuous butt-strap joints, the two-spar arrangement is retained, but heavy-gauge skin and stringers take the place of concentrated spar booms to provide the high torsional stiffness necessary for the speeds attainable. Between the spars of the inner portions of the outer wing are the four integral fuel-tanks. The ailerons, which extend over more than half the outer wing span, are unbalanced aerodynamically and power-assisted hydraulically in the ratio of 5:1. Piano hinges on the upper surface allow complete sealing and internal mass-balancing and a manual trimmer are incorporated. Split flaps, hydraulically operated, extend from the outer wing roots to the ailerons, and additional split-type dive brakes are fitted on the centre-wing and the aft section of the nacelle. Those on the centre wing can also be used as landing flaps. Extension or retraction time is approximately 10 sec.

Unusual Tail Features

The empennage consists of an upper and lower fin section with a high-set tailplane, double rudder and double elevator surfaces. The rear surface of the elevator is operated manually, but power operation is provided for the forward auxiliary surface. Electrical trimmers, which can be manually operated if desired, are fitted. Of the two unbalanced rudder surfaces, the rearmost is manually operated and, as in the case of the elevator, the forward auxiliary surface has power operation. Normally the manual surface only is required, the auxiliary surface being brought into play in the event of engine failure at low speeds.

Main and nose units of the undercarriage have twin wheels; all wheels retract forwards, the main wheels, when raised, lying between the jet pipes. Retraction time is approximately 8 sec. The nosewheel shock-absorber unit is of the Dowty liquid-spring lever-suspension type, and each main undercarriage unit consists of a telescopic leg, likewise utilizing liquid springing. Undercarriage operation and nosewheel steering are electro-hydraulic.

Of push-pull type, the main flying controls use aluminium-alloy tubes to eliminate differential expansion

and contraction under extremes of temperature. The hydraulic unit, which gives a 5:1 boost to the pilot's effort in moving the ailerons, is located on the rear spar on the centre line of the aircraft; a manually operated emergency by-pass cut-out for use by captain is mounted on the pedestal. A Pioneer PB.10 automatic pilot, modified especially for use on high-speed transport aircraft, is fitted.

The four Derwent 5 turbojets are mounted in pairs in two underslung nacelles. Welded chromium-molybdenum steel tubing is used for the mountings, and accessories are grouped in each nacelle on gear box located between the turbojets and attached to the front spar. The upper half of the cowling is a permanent structure, provided with small doors for slinging and a larger door to permit access to the upper part of the accessory gear box; the lower half consists of two large doors swinging to the sides of the nacelle and one door swinging to the rear. By uncoupling the jet pipe, drive shaft, connectors, and detaching the unit from the mounting and lowering it direcly on to an engine trolley, a Derwent can be replaced in a very short time. A CO_2 system is provided for the gear box compartment.

Fuel Systems

Each group of two turbojets has its independent fuel system, but fuel from any tank can be delivered to any power unit. Normally the Derwents are fed from the inboard tanks, which have a total capacity of 1,320 Imperial gallons. Fuel from the outboard tanks, of 980 Imperial gallons capacity, is continuously transferred to the inboard tanks at a controlled rate. By means of the by-pass valves the Derwents can be fed, if required, direct from the outboard tanks. Booster pumps in each tank deliver fuel, free of vapour and air, at a steady pressure of 6-8 lb/sq in at any operational altitude; the Derwents can, however, function with the booster pumps inoperative. Any appreciable difference in the weight of fuel on either side is indicated by a warning light, which enables the pilot to correct the trim of the aircraft by manual selection of tanks. Under-wing refuelling points, one on each side of the aircraft, are provided, and allow fuel to be taken aboard at the rate of 400 gallons a minute.

At each accessories gear box is a high-capacity alternator, supplying power to the anti-icing system, which utilizes a resistance-wire embedded in pads, attached to the leading edges of the outer wings, fin and tailplane. Warning lights are installed to indicate any fault in the functioning of the system. The alternator has voltage regulation, temperature protection, and an additional safety unit which ensures satisfactory operation at the extreme ends of the engine speed range under full load. To prevent the resistance-wires burning out during ground testing a safety device is also incorporated in the pad system.

The air-conditioning and pressurizing units are integrated into a completely automatic system to supply fresh air to the passenger cabin at a comfortable temperature and pressure for all flight conditions. Filtered or ram air is passed from wing intakes to two cabin superchargers, one on each power plant gear box. Each supercharger has a capacity of approximately 30 lb of air per minute at a height of 30,000ft; the maximum cabin pressure differential is 8.3 lb/sq in, and automatic control of pressure is maintained by a discharge-valve set to provide sea-level conditions up to 21,500ft. At 30,000ft the pressure is equivalent to that at 4,000ft, and rate of pressure-change during climb and descent is also controlled automatically and can be preset by the pilot to the desired value. Temperature of the ventilating air is governed by equipment in the accessory compartment. Heat is supplied by a combustion-type heater of 200,000 b.t.u. per hour capacity, and cooling is effected by heat-exchangers and a cooling turbine. A ground-conditioning connection is provided, and equipment may be installed for heating the cabin air on the ground. Humidifying equipment can also be supplied. Ditching valves, to prevent ingress of water during an emergency alighting, are controlled by the co-pilot.

In the 40-50 passenger version double seats are arranged on each side of a central aisle, but for high-density work 60 passengers can be carried by installing five seats abreast, with a 19-inch aisle. The stewardess's position, with folding seat and table, is at the after end of the cabin.

A. V. ROE (CANADA) C.102.
Four Rolls-Royce Derwent 5 (civil) turbojets

Dimensions	
Span	98ft 11in
Length	82ft 9in
Gross wing area	1,157 sq ft
Aspect ratio	8.31
Mean track	22ft 6in
Weights	
Max take-off weight	60,000 lb
Max landing weight	52,500 lb
Performance	
Max cruising speed	427 m.p.h. at 30,000-35,000ft
Max still-air range (without allowances)	1,400 miles

R.Ae.C. AVIATORS' CERTIFICATES

A RECENT list of R.Ae.C. Aviators' Certificates covering those issued between July 4th and August 5th, is given in the table below (previous list, p. 146, *Flight*, August 4th).

No.	Name	Club or School	Date
26,047	Eric Darwent Ward	Qualified Service pilot	4.7.49
26,048	Robert Alexander Innes	Qualified Service pilot	7.7.49
26,049	James George Charles Carney	Qualified Service pilot	5.7.49
26,050	Pierre Eugene Rongier	Holds French licence	7.7.49
26,051	Arthur Kenneth Baker	Auster Flying Club	7.7.49
26,052	Jeremy Cecil Addis	Marshalls Flying School	7.7.49
26,053	Kenneth Marden Henfrey	Qualified Service pilot	11.7.49
26,054	Cyril James Palmer	Marshalls Flying School	11.7.49
26,055	Douglas Raymond Andrews	No. 24 R.F.S.	11.7.49
26,056	John GrahamWalker	"	11.7.49
26,057	Eric William Robson	"	11.7.49
26,058	Donald Blan Minterne	"	12.7.49
26,059	Colin Morris Britland	"	11.7.49
26,060	Vernon Richard Kerry	"	11.7.49
26,061	Graham Burnett Stirling	St. Andrews U.A.S.	12.7.49
26,062	Joseph Ross Ingram	"	12.7.49
26,063	Leonard Andrew Stapleton	Wolverhampton Aero Club	12.7.49
26,064	Michael Dan Howlett	"	12.7.49
26,065	Colin Harry Thomas Cables	Qualified Service pilot	12.7.49
26,066	Basil Breach	Wolverhampton Aero Club	13.7.49
26,067	Donald Edwin Stephen Newport	No. 7 F.T.S.	14.7.49
26,068	Stanley Blackbourne Oliver	Qualified Service pilot	14.7.49
26,069	Brian Sidney James Lamb	No. 7 F.T.S.	15.7.49
26,070	Peter Richmond	Qualified Service pilot	15.7.49
26,071	Jon Nicolas Holthusen	No. 7 F.T.S.	18.7.49
26,072	Edward William John Morris	"	18.7.49
26,073	Mervyn John Ayres	"	18.7.49
26,074	Don Blew	Qualified Service pilot	20.7.49
26,075	Peter Pearson Sidebottom	Blackpool and Fylde Aero Club	20.7.49
26,076	Robert William Harry Goodrum	Teesside Flying Club	20.7.49
26,077	John Arthur Worrall	No. 7 F.T.S.	20.7.49
26,078	William James Davies	Qualified Service pilot	22.7.49
26,079	James William Parritt	No. 7 F.T.S.	27.7.49
26,080	Eric Wright Barber	Newcastle-on-Tyne	27.7.49
26,081	Elspeth June Godsall	Devonshire Flying Club	26.7.49
26,082	Burjor Rustom Gazdar	Herts & Essex Aero Club	27.7.49
26,083	David Henry Gason Ince	Wolverhampton Aero Club	3.8.49
26,084	Arthur John Hale	No. 7 F.T.S.	3.8.49
26,085	Robert Elder	"	3.8.49
26,086	Caleb Griffiths	Cardiff Aero Club	3.8.49
26,087	Marcus David Parry	South Coast Flying Club	5.8.49
26,088	Raymond Hoggarth	Qualified Service pilot	5.8.49

FOR THE STUDENT

"Aeronautical Engineering," by R. Tatham, B.A. A.F.R.Ae.S. English Universities Press; price 10s 6d.

MR. TATHAM has produced a generously illustrated text-book containing a wealth of information for the student engineer. While admitting that it is, of necessity, a book which requires more than a mere nodding acquaintance with the principles of aerodynamics and calculus in order to absorb fully its presentation of practical examples and calculations, one feels that the author might attract a considerably larger section of the aeronautical student body (particularly in the *ab initio* category) by being a little more explicit in his approach to the diverse and complex aspects with which he deals.

The title itself, *Aeronautical Engineering*, leads the reader to expect a rather more comprehensive treatment of the subject. Nevertheless, the book is the first of a series and it may well be that in subsequent volumes the author intends to fill in the gaps and so achieve what should prove to be an up-to-date and informative reference-work for the aspiring aeronautical engineer.

AMERICAN NOTEBOOK

By "Favonius"

JETS BE DAMONED!

ALTHOUGH on their native heath the British people might fairly be called a sporting nation and a good risk for the bookies, on the international race-course they are apt to confound the betting. By all the rules of global gamesmanship they should stay back in third place, letting the two out-front stage most of the grandstand play. This is shrewd jockeying while getting one's second wind, and now that the wind turns out to be a jet blast, the raucous voices in the grandstand may become a little more restrained; indeed, one or two even sound a bit strained.

There is no doubt that the successful début of the de Havilland Comet has caused a widening ripple of concern throughout the American aircraft industry, the major airlines, and the Congressional policy-makers. On the policy side, this trinity have been bickering over a financial formula for the prototype development of government-sponsored civil transport aircraft, while in the technical realm they hang suspended between the fuel economy of the turboprop and the speed-altitude comfort of the turbojet. After all this dickering with paper darts on the drawing board, it comes as a bit of a jolt to them to see the British torch-bearer riding high in the stratosphere.

American comments on the Comet vary from the penetrant to the piquant, and one or two even border on the petulant. The penetrating observations, as might be expected, come from the engineering fraternity, frustrated by dollar-pinching on the civil side while dipping deeply into Uncle Sam's pocket on the military side; more piquant, if a little reactionary, are recent comments of top airline executives—who should have guessed better; and the peevish voices, we suspect, belong to the Anglophobes keenly looking forward to the inquest on John Bull's body—only to find the old codger rounding the bend and breathing better than ever.

That the bookies have become a little confused over the form of the horses still in the stable is shown by an editorial comment in one of the U.S. aviation monthlies, which says:

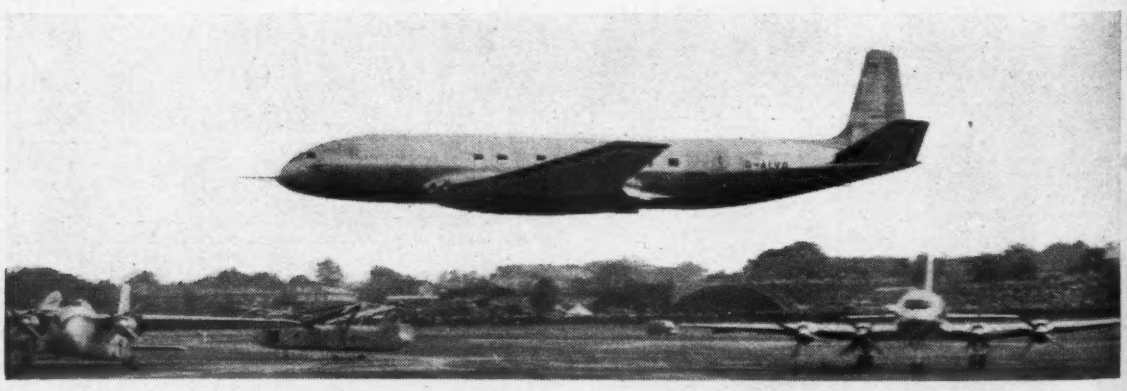
> "Our British friends are doing a good job of gloating in print over the fact that American aircraft designers 'missed the boat' in wanting to go straight from piston engine transports to jets, by-passing propeller turbine engines. According to reports in the British aviation Press, Americans are now asking the advice of British aviation experts on the design of future airliners. They further state that the Aircraft Division of the Society of Automotive Engineers, which went overboard at their 1948 Los Angeles meeting in endorsing jet-engined transports for 1955, has now revised its specifications and at their 1949 meeting will discuss the turboprop engine for this transport."

Our own recollection as a silent observer of the aforesaid S.A.E. meeting last year is something quite different, so we trust our chief commercial competitors (let's be honest with our friends as well as ourselves!) will not think we are "gloating in print" if we clear the air a bit. Actually, only two design teams, Douglas and Lockheed, came flat out for a 1955 jet transport, with Convair—the third member of the design panel—straddling the fence, possibly waiting for a civil-type-tested turboprop unit for conversion of their Convair-Liner. As a matter of fact, they are still waiting for the Allison T-40 turboprops to show up for installation in the new Convair XP5Y-1 boat, so the prospects for a civil turboprop unit are hardly likely to materialize for a bit.

The Northrop team played possum during these discussions, although they were known to be busy making studies of a turbopropped civil version of the Flying Wing, designed around their 10,000 h.p. Turbodyne engine. To date, this somewhat ambitious turboprop project—which began life as a turbojet and then got crossed up by the U.S. Navy—is reported to have delivered about 7,000 h.p., which indicates that several more years must elapse before it can be counted upon to deliver its designed output as an ordinary day-by-day commercial performance.

Again, it may not be generally known that Northrop's, working in conjunction with the airscrew industry, are designing the Turbodyne as a pusher turboprop combination which, perhaps, serves to emphasize the experimental nature of this project. The really difficult problems are likely to crop up when the gearing, airscrew and jet-exhaust snags have to be fought out. Nevertheless, we would certainly like to see this enterprising group of heterodoxists get away with it. The question mark, however, still remains: will it be worth the price of the technical know-how in comparison with the contemporary status of the pure jet, say, in 1955?

The airline operators, as represented by their top engineers, were blissfully blind to the charms of both turbine schools, prop and jet—all they asked for was to be left alone to make some money with their pumping pistons; in fact, their idea of a 1955-65 airliner was astonishingly modest for Americans: they would be quite happy with nothing bigger and faster than a piston-engined 120,000-lb 50-seater cruising at 350 m.p.h. at 30,000 feet. The airscrew section of the industry, naturally enough, put up a



The British cat that has caused more than a little flutter in the American dovecotes. "Its inaugural flight . . . put the United States and the rest of the world at least three years behind technologically in this field," admits one expert observer across the Atlantic.

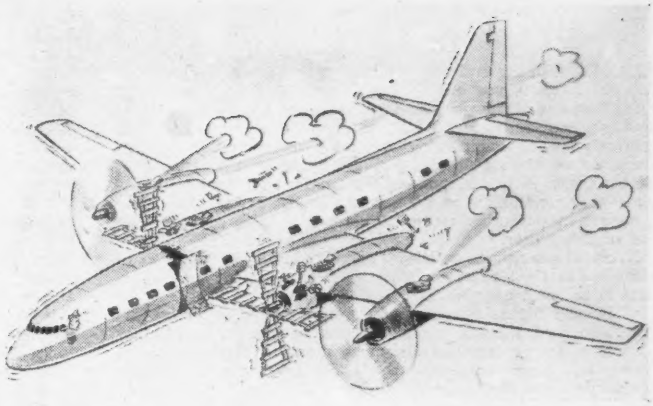
last-ditch case to prove that turboprops would be able to match the jet with a propulsive efficiency of 80 per cent as far up the speed scale as 550 m.p.h.

If, then, it be true that the S.A.E. is now going overboard on the turboprop, one is prompted to enquire where suitable U.S. power plants are coming from and when they are likely to be available for civil aircraft constructors. Certainly, at the moment, the outlook in the U.S.A. does not appear too encouraging in this branch of the turbine art and one cannot help feeling that Douglas and Lockheed—and, possibly, Boeing—are displaying the more forward-looking imagineering in jumping the turboprop ditch and going all-out for the jet, especially bearing in mind that a transport designed in 1950 for 1955 must really look as far ahead as 1965. The advent of the Comet is the ghost-writing in the sky.

That the Comet gives Britain a wide edge over the rest of the field in jet-transport design is readily acknowledged by the more penetrant engineering observers over here. Robert McLarren, Engineering Editor of *Aviation Week*, writing in the August 8th issue of that journal, remarks, apropos the Comet, that: "Its inaugural test flight on July 27th opened a new era in commercial air transportation, and put the United States and the rest of the world at least three years behind technologically in this field." We can certainly confirm that our engineering friends at Douglas and Lockheed have been working overtime with their electric erasers since the Comet appeared over the horizon.

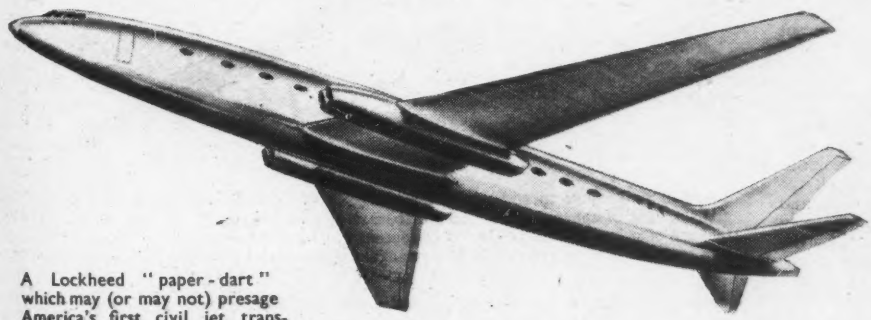
The same well-informed writer (a trained engineer, by the way) goes on to say that: "The small area of the vertical surfaces is causing considerable controversy among American engineers. Despite the close-in location of the power plants, U.S. engineers are confidently predicting added fin area in the not too distant future if adequate control during landing and take-off is to be assured." In other words, the betting on this side is that the Comet's tail will spread out a bit before it gets much farther along its orbit. Remembering the classic example of the Boeing Clipper boat, whose vertical tail deficiency was obvious to every engineering observer except the designer thereof, we will keep our fingers crossed (and pencil in pocket) and await further development.

We might as well sign off this page of our notebook on a piquant note by quoting another old acquaintance of ours—one of America's leading airline executives, in fact. Like most American airline operators—who have just got back into the black after several post-war years in the red—Ralph S. Damon, President of Trans-World Airlines, is conservative on the subject of jets. During a recent visit to Los Angeles, when asked by the local news-hawks to comment on their commercial possibilities, he is reported to have said: "Not for about ten years would be my guess. Jets are much too expensive in terms of fuel weight."



Death-dance of the prancing pistons: A "vibrant" caricature on windmilled transport design for 1955 by Lockheed's chief research engineer, Kelly ("Don Quixote") Johnson.

In the land of the biggest, the fastest, the richest, and all things superlative (and downright supernal), it is a strange new experience to hear airline executives and their engineering directors defending the status quo—and meanwhile the jets are whistling a torch-song for the demise of the prancing pistons. Even stranger is the thought of Damon and Pythias (in the background shadow of Howard Hughes) being satisfied with the piston-engined transport for another ten years—a prospect which is neither pleasing nor logical, since it presumes that jet-unit and airframe designers will be content to concentrate on the military exploitation of the jet to the exclusion of the civil. Happily, de Havilland, Avro (in England and Canada) and Vickers now bear witness as torch-bearers for civil aviation.



A Lockheed "paper-dart" which may (or may not) presage America's first civil jet transport. This is a more serious design proposal by Kelly Johnson for a 1955 four-jet 40-seater airliner weighing 150,000 lb and cruising at 530 m.p.h. at 37,500ft. Fuel would be carried in mid-section of fuselage with passenger cabins fore and aft.

Now that Damon has joined forces with multi-millionaire Hughes, one might have expected a little more imagineering in the jet-transport future in America, for Ralph Damon has a long and excellent manufacturing background with Curtiss-Wright to buttress his later airline record with American Airlines; while Hughes certainly can put up financial backing and has the sporting urge to risk it—as shown in his big flying-boat venture, into which he has recently sunk a further couple of million dollars of his own money for repairs and redesign.

All the same, we find it hard to believe that there is any place in the sun for a piston-engined wooden flying boat in the jet half of the 20th century; nor do we think that the Americans will permit jet transports to be "damoned" for a decade, especially in view of the competitive urge engendered, oddly enough, by a so-called "Welfare State." From where we sit in the grandstand we can see the jet horses rounding the bend and coming up much faster than that. Perhaps (who knows?) the austerity oats of the British stable have improved the breeding strain. It *has* happened before in the long and rough island story.

JETS BE-PRAISED!

WE were just on the point of licking the envelope and waving the foregoing thoughts goodbye when along came some very interesting and frank comments on the same subject from Wellwood E. Beall, Boeing's Vice-Presi-

American Notebook . . .

dent of Engineering and Sales. That title, by the way, means that Mr. Beall is not only one of America's top engineering brains, but one of the shrewdest aircraft salesmen on the North American continent. Mr. Beall, in common with the rest of America's leading engineering and sales executives, is rightly exercised over the status of the civil jet transport in America; and his thesis is so well put—albeit from an American standpoint—that we think it worth quoting almost *in extenso*. The comments in parenthesis can be blamed on the unrepentant head of this writer.

Mr. Beall's script is entitled "*Jet Transport Economically Feasible, but Development Awaits Funds and Planning.*" He starts in to bat by saying that:

"Recent flights of jet-powered experimental airliners in England and Canada point up one of the most serious problems facing American aircraft manufacturers and airlines, and (with emphasis) the U.S. Government. While Britain's subsidized aircraft industry has built and flown no less than six different jet-powered airliners, and is in production on some of these, we not only do not have a commercial prototype flying in this country, but have not even begun construction of an experimental model."

(By "jet-powered," Mr. Beall probably means "turbine-powered," embracing both turbojet and turboprop power plants. And since roughly 82 per cent of the American aircraft industry has its hands deep in Uncle Sam's military pocket, it seems a trifle wistful to describe the British effort as "subsidized." Another odd fact is that Boeing themselves are welfare recipients of what all enterprising Americans call the British "Welfare State"—to the extent of $12 million for Boeing civil airliners!)

"At the same time the successful operational testing of our two XB-47 Stratojet bombers—the first swept-wing large aircraft—continues for the USAF. Since the first XB-47 flew in 1947 these aircraft have consistently exceeded performance guarantees and have proved themselves to be conventional in all respects except appearance and performance. Production quantities are now rolling through our Wichita factory."

(Boeing are also expending a lot of engineering time on their super-jet bomber, the eight-engined XB-52, which is scheduled to replace the piston-engined Convair B-36 by 1954. Despite all the best-laid schemes of mice and men and machinery, engineering manpower and brains are likely to be the critical bottleneck, now, as in the past—which means that a nice balance must be struck between military and civil priorities; 82 to 18 looks a bit top-heavy to us.)

"Because of the very nature of aircraft design and development work, no company can risk its capital in the building of a wholly new type of aircraft such as the jet transport. The interdependence of national defence and commercial air transportation makes absolutely necessary the maintenance of a strong, up-to-date and flexible airline system which is available to the military in time of emergency.

"Manufacturers in this country are for the moment stopped dead in their tracks. We at Boeing, for instance, are in the position of having on our drawing boards advanced type jet transports which are the next logical step ahead of anything now flying abroad. Our studies show them to be not only economically feasible, but from the military standpoint absolutely essential to a well-rounded defense programme."

(Here is that hoary chestnut again—when is a subsidy not a subsidy? Presumably when it comes off the board painted in military camouflage as a prototype military transport! The British way is more brutally direct, but the final end result is precisely the same—the taxpayer pays. And, of course, he should be proud to do so in the national trading interest, whether British or American. It really all boils down to long-term imagineering—that is, building for the future. First, of course, you must have faith in the future—which is where the Brabazon imagineers and, possibly, even the much maligned "Welfare State," will be remembered in British aviation history.)

"Our studies show that we could have a prototype 500 m.p.h. jet transport flying within 18 months of receiving a contract. Such a transport would be admirably suited to all routes from 200 miles to 2,500 miles. These studies are based on existing Civil Air Requirements, which in effect penalize the jet, because they were set up for wholly different categories of aircraft. For this season our studies must be on the conservative side.

"We find that at a design range of approximately 1,000 miles plus ATA reserve fuel, for instance, the jet transport has a comparable direct operating cost to both turbo-prop and piston-engine transports. At design ranges of 3,000 miles or more the jet suffers somewhat because of excessive fuel weight required. On very short range routes the jet suffers because of the higher percentage of climb fuel required and the higher penalty imposed upon block speeds for the faster aircraft."

(The reference to jets being suitable for route stages as low as 200 miles appears highly controversial. A jet aircraft is essentially a high-speed, stratospheric flyer and needs a fair distance in which to climb and operate economically, otherwise its fuel consumption is prohibitive. This is admitted—in a roundabout way—by the last-quoted sentence.)

"We find from comparative data that a jet transport operating at a design range of 1,000 miles offers greater profit and speed potential than either turbo-prop or conventional piston-engine airliners even at 50% load factor. The medium size, medium range jet transport seems to be the logical next step for domestic airlines serving major population centres of the United States. Actually, a fleet of jets as outlined would effectively serve up to 90% of available domestic airline passenger traffic. Larger piston or turbo-prop transports seem indicated for extreme long range until better specific fuel consumption is in sight for the pure jet."

Shape of civil wings to come? The Boeing XB-47 Stratojet bomber has a current gross weight of approximately 165,000 lb, a wing area of about 1,400 sq ft, and a fuel tankage of at least 11,000 U.S. gal in the fuselage. The problem in the civil jet with fuselage tanks is how to get the 40-50 passengers shoe-horned into the remaining space.

(The last sentence is debatable on several grounds. A large jet transport might take five years to develop to the production stage, by which time the pure-jet unit is bound to have made considerable progress; you can test this by looking back five years. It also depends a great deal on the aerodynamic configuration selected for argument. On the results already achieved with the Northrop YB-49 Jet-Wing bomber, a trans-oceanic range of 4,500-5,000 miles carrying 80-100 passengers appears perfectly feasible today—which means it could be operational by 1955. The extra bit of imagineering needed might pay off; anyway, it makes a good engineering argument!)

"The effect of high speed, and therefore greater untilization, dictates more frequent schedules. Therefore, it seems advisable to reduce seating capacity to a minimum consistent with efficient utilization of fuselage shape and volume. Forty to fifty passengers is indicated as the best figure for a high speed jet transport such as we envisage. Because

American Notebook : : :

the operating cost in the transonic and supersonic range is so high as to preclude the economic feasibility of such a transport, it is believed that a jet transport in the 500-525 m.p.h. class would not be obsoleted for many years to come.

"An aircraft taking advantage of swept-wings, smooth surface and clean design can push very close to the sonic zone with safety and economy. Our B-47 Stratojet bomber, as large as the wartime B-29, but almost twice as fast, is a case in point. Design features of this six-jet aircraft enabled it to fly the 2,289 miles from coast to coast at an average speed of 607 m.p.h. It can carry a pay-load (in this case, bombs) of 22,000 lb. True, the B-47, as it is, would make a very fast commercial jet transport; however, for commercial use, slightly lower cruising speeds and reduced wing loading would be more economical."

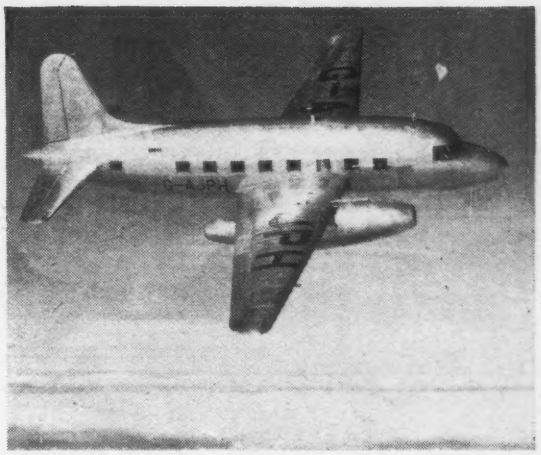
(We believe the current take-off wing loading of the XB-47 is around 115-120 lb/sq ft, whereas that of the Northrop YB-49 is between 50 and 55. A civil jet needs adequate wing area for three pertinent reasons: (1) high cruise ceiling; (2) good take-off and landing characteristics, preferably without rocketry and tail umbrellas; and (3) ample fuel-tankage capacity—perhaps the most over-riding design requirement of the lot. The adoption of the razor-blade, high-aspect-ratio-wing inevitably means fuel tanks in the fuselage and exposed barrel-type engine nacelles or underslung pods—all of which strike us as retrogressive civil design for 1955. We need to get clear away from the military missile school of design.)

"The C.A.A. must immediately begin to think of changes in regulations which will be required to certificate this new type of equipment. For example, jet performance will mean a revamping of cruising speed limits, so that a more efficient operation will result. Airway procedures and airport landing facilities will need certain revisions, just as introduction of high speed conventional transports during the post-war years has necessitated a revision of pre-war procedures.

"It should again be pointed out that this necessary groundwork takes time and money. And it will take still more of these two most valuable elements to built, test and certificate a prototype. It will take additional quantities of time and money to get into production. The process cannot be shortened; corners cannot be cut. Our experience with the successful B-47 swept-wing bomber leads us to believe, however, that we have the next step—a commercially feasible jet transport—well in hand."

(Every experienced engineer will heartily agree with Mr. Beall's credo that "corners cannot be cut"—which gets back to our own dogma of the engineering bottleneck and the relevant order of military and civil priorities. Much as Americans like to pride themselves on hustling things, there is no substitute for TIME. While it is undeniable that Americans do get things done in a hurry, the Brabazon imagineers may prove that it sometimes pays to hasten slowly—and take five minutes off for a cup of tea!)

"It could well take an additional two years to put such a new transport into airline operation after the prototype flies. British manufacturers, with a wealth of jet experience, do not expect to have such airliners in actual service until 1952-53. If we were to start prototype development right now we could have in operation a superior design soon after the British. We at Boeing's have just spent some 20 months in testing and certificating the Stratocruiser, a large but *conventional* transport. Certification of a wholly new class of aircraft, such as a jet, will necessarily be a process not only long, but expensive. The process should be started now."



Know-how accumulator: Much of this country's civil jet advancement is due to the use of flying test-beds such as the Nene-Viking. America conducts no comparable programme.

(A precisely similar plea was made a year ago by Douglas and Lockheed engineers at the S.A.E. Los Angeles meeting. Apparently, it has taken the appearance of a Comet over the eastern horizon really to shake things up in the U.S.A. Now that our American friends—and keenest trade competitors—are on the move in this direction, it behoves us to call the pace, for we cannot afford to be complacent. All the same, we strongly doubt whether an American jet transport moulded along B-47 military lines would prove superior to de Havilland's current design philosophy, particularly as regards the wing and power-plant installation features.)

"Government financial aid will be required if we are to overtake and pass the subsidized British aircraft industry in its bid for domination of the future jet transport field. As things stand to-day, it may well be that we will lose not only world markets to the British jets, but because of competition may find our own airlines forced into 'buying British' for lack of such types in this country."

(The idea of buying more-advanced turbine-powered civil aircraft and engines from the British ought surely to appeal to our American friends as a sporting gesture. After reverse lend-lease during the war, what could be more fitting than reverse Marshall Aid in the post-war readjustment period. Moreover, as the pound is devalued we could offer some very nice bargains. For years now British subsidized airlines have been buying American equipment, so a sprinkling of Comets and Brabazons might add sprightliness and dignity to the American scene. In fact, *quid pro quo*, is really the moral of this discourse. And competition, anyway, is always good for trade.)

INSTRUMENTAL PRECISION

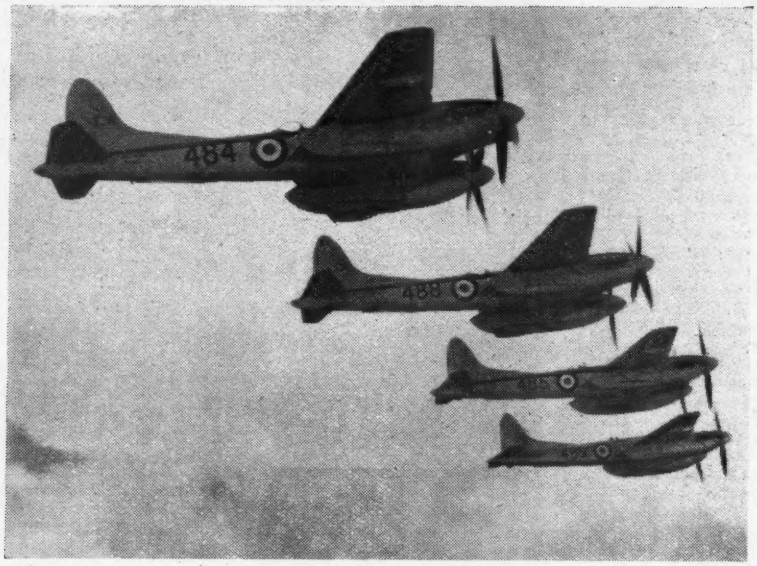
THE makers of Pullin instruments—R. B. Pullin and Co., Brentford, Middlesex—have recently developed a new type of electrical turn-and-slip indicator, a large quantity of which have been ordered for installation in new Service aircraft, including jet types. These instruments, which, it is stated, are the only examples of their type to be approved for Service aircraft installation, embody a number of refinements of design. For instance, the use of non-linear scales, both for turn-and-slip indications, allows "open" divisions in the zero region, whilst the gyro rotor has the remarkably low speed variation of less than ±0.5 per cent throughout the voltage range. The rotor itself is the armature of the motor, which rotates around a fixed internal field; the motor is self-screening.

The light-alloy gimbal in which the motor is assembled is cast in two split sections, so permitting the largest possible gyro to be fitted within the available space. The fact that the instrument has a recommended inspection-period of 1,000 hours may be taken as a significant commentary upon the design and construction. Commutator-brush wear—and consequent dust—is kept to a minimum even at high altitudes, where the very dry atmosphere tends to increase wear. Minimum wear is achieved by the low current consumption (less than 3 watts), by the low running speed of the large rotor and by the particularly large cross-section brushes. The bearings are further protected from dust by labyrinth excluders.

Whereas the pendulous inclinometer type has been chosen for R.A.F. use, a ball-and-tube type is also available and both are sufficiently sensitive for a 1-deg deviation from the correct bank angle to be clearly indicated. Power supply can be either for 12- or 24-volt systems and, in addition, a model with specially calibrated rates of turn for sailplane installation has been approved, after trial, by the British Gliding Association.

CREDIT BENSON

THOUGH crowded car parks were the rule at almost all the Battle-of-Britain Week "At Homes," credit should be given where it is due—the particular crowd shown in a photograph on p. 372, September 22nd, was attracted by Benson, and not by another station.



"HERON" AT HOME

R.N. Station, Yeovilton, Entertains the Public

(Left) Sea Hornet 21 night fighters of 809 Squadron gave a particularly polished display of formation aerobatics.

(Below) Admiral of the Fleet Lord Fraser of North Cape inspects the guard of honour on his arrival.

UNCONCERNED with Exercise *Bulldog* and undismayed by deteriorating weather conditions the Royal Navy gave of its best at Yeovilton last Saturday and drew a crowd of some 12,000 spectators.

Early in a very entertaining programme were eight Seafires of 1832 Squadron R.N.V.R. to show the batsman-controlled technique of carrier landings. On Fireflies, Lt. Benson demonstrated a rocket-assisted take-off and David Masters (Fairey test pilot) gave an excellent aerobatic performance. Eight instructors from the R.A.F. Parachute Jumping School at Upper Heyford "hit the silk" and landed with great precision 100 yards in front of the crowd; three Meteors from C. F. S. gave a polished performance of formation aerobatics, terminated by a formation landing; and there followed an agile demonstration of the Spitfire Trainer, given by Jeffrey Quill.

In more sober mood, but of great interest, was the well-positioned landing and snatch pick-up of a Hadrian glider, with the assistance of a Dakota from R.A.F. Transport Command.

Now in production for Naval Aviation, the Westland-Sikorsky S-51 demonstrated its capabilities in rescue work. The lorry represented a moving ship.

No Royal Naval air display would be complete without the engineless aerobatics of Lt. Cdr. Sproule, and once again he delighted all spectators with the extraordinary *finesse* of his sailplane display, brought to a finish by a precision landing in front of the main enclosure. Two Tiger Moths, piloted by F/L. Hough and Plt. II Bull, executed some remarkable antics in their exhibition of "how and how not to do it." A "single-engined" Sea Hornet flown by Lt. Ferguson performed some very fine aerobatics, the pilot frequently feathering one Merlin and starting the other between loops and rolls.

Neville Duke's startling arrival at 50ft over the enclosure brought everyone to his or her feet, but the full aerobatic capabilities of the Hawker P.1052 were not exploited because of low cloud—though fortunately it was not low enough to prohibit a demonstration of the 1052's magnificent rolling qualities in Mr. Duke's capable hands.

The D.H. Vampire and the Westland Wyvern, flown by Plt. I Atkins and S/L. Graves respectively, gave an impressive show, the Wyvern leaving a pattern of wing-tip trails against a background of dark cloud. The flying display was wound up by four Sea Hornet night fighters of 809 Squadron, which flew past in formation on port engines only.

GAS-TURBINE SAFETY

Anti-icing and Fire-prevention Arrangements on D.H. Ghost Civil Installations

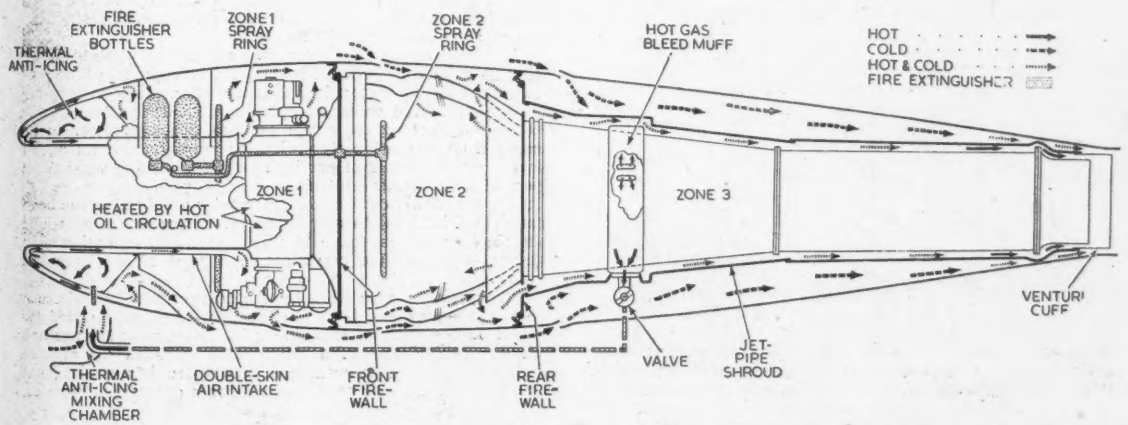
POWER-PLANT icing is admitted to be one of the chief operational problems likely to be met by the new generation of gas-turbine-powered transports, but recently a more confident note has been discernible when those engaged on the development of anti-icing systems have been approached for information. There now seems reason to believe that damage as a result of ice entering compressor air-intakes can be averted quite easily in the case of centrifugal-compressor turbojets and turboprops.

One of the few power plants in which anti-icing, fire-extinguishing and other systems have reached an advanced stage is that of the civil de Havilland Ghost turbojet as fitted in the Comet. The makers state that the centrifugal impeller is of sufficiently robust construction to permit quite large pieces of ice to enter the compressor without causing damage. Moreover, centrifugal effects prevent ice formation on the impeller blades. Remedial measures are therefore limited to the prevention of ice accretion in the air-entry ducts and on the front-bearing fairing and support vanes. Although the power output of a gas turbine is adversely affected if the temperature of the intake air is raised, the performance of the Ghost suffers little, if at all, as a result of the heating of the duct surfaces as the air temperature does not rise appreciably.

Two sources of heat are employed. One is from a bleed muff on the jet pipe, the muff being an annular duct surrounding the jet pipe just to the rear of the turbine. The hot air thus bled-off is piped forward to the nose portion of the air-intake fairing. The flow is controlled by a valve, and before being passed round the leading edge of the intake the very hot air is diluted with cold air from a small forward-facing intake. Operation of the system is clearly indicated in the accompanying diagram. The other source of heat—employed for the fairing for the front bearing and for the support vanes within the intake—is the circulation of hot oil from the engine system through these components.

Accessories and auxiliaries are contained in a still-air zone between the cowling and the intake duct, and are thus out of the main airflow and protected from icing.

Regarding fire control, de Havillands point out that the direct entry to the single-sided impeller enables the intake air to be isolated from all the cowled compartments around the engine. Thus, the nacelle can be divided into compartments separated by fireproof bulkheads which greatly reduce the risk of a nacelle fire, and the arrangement also results in a considerable economy in extinguisher fluid. The three zones on the Ghost are: (1) forward of the fire-wall on the compressor casing; (2) between this and the partition at the turbine shroud; and (3) rearward around the jet pipe, which carries its own shroud acting as a fire-wall for the pipe. A venturi cuff on the jet nozzle induces a strong airflow from Zone 2 along the Zone 3 annulus. This has the double purpose of ventilating Zone 2 and ensuring that the temperature of the jet-pipe shroud is kept at a safe level during ground runs. Incidentally, in the event of fire this airflow does not result in rapid dilution of the fire-extinguishing gas, because the pilot's first action is to cut off the high-pressure fuel cock. This cuts the power of the engine, and the venturi suction is reduced to negligible proportions.



Thermal anti-icing, fire extinguishing and ventilating systems for the Ghost. The nacelle is divided into three zones and simple toggle-fastened cowlings form the enclosure. An engine change can be accomplished, cowled to recowled, within the hour.

EVALUATING THE HELICOPTER

ON Saturday afternoon last, a notable paper entitled *Some Economics of the Helicopter—Present and Future*, was presented before the Helicopter Association of Great Britain by Mr. L. S. Wigdortchik, A.F.R.Ae.S., who is Chief Experimental Engineer of the British European Airways Helicopter Unit.

Too often, in lectures dealing with the economics of air transport, the pro-aeronautical bias of the lecturer tends to make him gloss over the unrelenting necessities of economic survival. These are usually manifested in the plain argument of how much return can be derived from a given outlay and, in general, aircraft do not show up as well on this standard as do most other vehicles. Mr. Wigdortchik, however, had composed a paper of admirably balanced proportions, and it was evident that whatever professional bias he has towards the helicopter, he is not blind to the severely practical economic standards which it must fulfil if it is ever to become a business proposition. His lecture was the more important by reason of the fact that it was almost certainly the first of its kind based on a considerable practical experience of helicopter-operating economics. A digest will appear in *Flight* next week.

Following edification in the afternoon, members of the Helicopter Association gathered for their annual dinner in the evening at No. 6, Stanhope Gate, Park Lane; a most enjoyable and convivial affair.

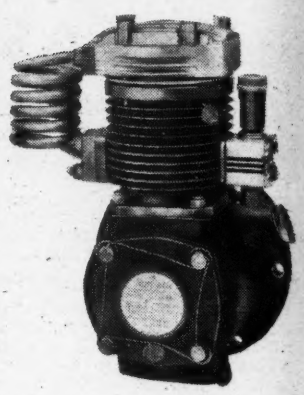
PROTECTION BY PHOTO-CELL

SOME of the many industrial applications of electronic control equipment, particularly in conjunction with photo-electric detection, were shown at a recent demonstration staged by Radiovisor Parent, Ltd., of 1, Stanhope Street, London, N.W.1.

Among the apparatus demonstrated was a smoke-detector for the protection of buildings from fire, in which two photo-electric cells are illuminated by independent light-beams and electrically "balanced" so that equal interruption of both beams (e.g., by fog) will have no effect, whereas independent interruption, as would be caused by smoke from a fire, energizes an alarm circuit. It is understood that an adaptation of the system for airborne use is under consideration by the manufacturers.

Other exhibits included "invisible ray" intruder-alarm systems which, as they can be equally well operated out of doors should be of considerable value for perimeter-fence protection

AIR-COMPRESSOR IMPROVEMENTS

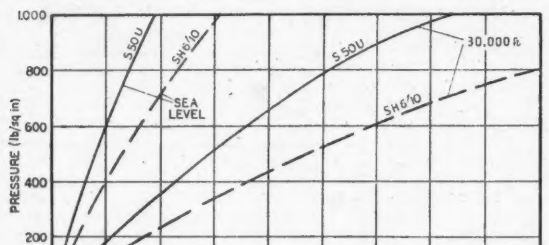


Hymatic Two-stage Intercooled Unit Rated for 1,000 lb/sq in : Development work on 3,000 lb/sq in Type

IN the British aircraft industry the name Hymatic is synonymous with air compressors, and in this connection it is noteworthy that the basic design of the Hymatic compressor has remained unchanged despite an increase in generating capacity from 300 lb/sq in to 1,000 lb/sq in.

There has, nevertheless, been a coincident demand for improved performance in output and ability efficiently to pump at high altitudes, and during the past four years the company has undertaken considerable research in an endeavour to meet such requirements. This work first resulted in a unit designed for a supercharged supply from a gas-turbine compressor, and the soundness of the new basic design was proved after extensive tests on engines and gearboxes and on the Mamba-Balliol. It was subsequently found, however, that when treated as a normally aspirated unit but fitted with a smaller inter-stage cooler, the new compressor offered considerably improved performance characteristics by comparison with its predecessor. Development work was then concentrated with the aim of producing a single basic compressor which could be available for use either as a supercharged or normally aspirated unit, depending on the cooling arrangements adopted.

The compressor which resulted from this research has now satisfactorily passed its type test and, designated S50U, follows to some extent the established Hymatic practice in employing a two-stage single cylinder with truncated piston. Thermal efficiency has been improved to the extent of giving an increase of 35 to 55 per cent in performance (depending on the pressure) for a corresponding weight penalty of less than 15 per cent. Other modifications in design have indicated during the test programme that at least twice the life between overhauls (in comparison with the well-known Hymatic SH6 series compressor can be achieved), whilst pumping to full pressure can be maintained above 40,000ft. In point of fact, pressure generation falls only to 650 lb/sq in at an altitude of 49,000ft.



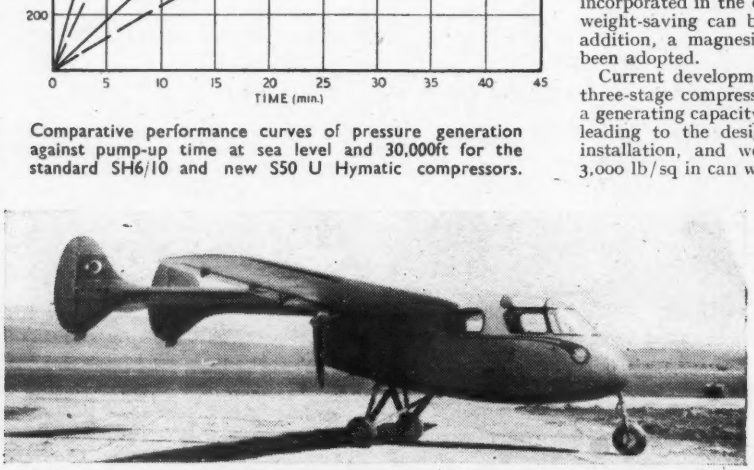
Comparative performance curves of pressure generation against pump-up time at sea level and 30,000ft for the standard SH6/10 and new S50 U Hymatic compressors.

As an aid in obtaining improved performance at altitude, the poppet inlet-valve has been replaced by a very light and simple ring valve. In the SH6 series compressor, the compressed air delivered by the first stage was passed to the second stage annulus by a transfer valve and so, consequently, was hot; cooling of the compressor was, therefore, critical when working at the higher pressures, and the cruising r.p.m. had to be dropped from 1,500 to 1,200 if an economical life at 1,000 lb/sq in was to be obtained. By the introduction of inter-stage cooling in the S50U design, however, the air is delivered to the second stage at as little as 50 deg C. As a result, higher speeds can confidently be accepted without reduction in compressor life, and, for 1,000 lb/sq in in generation, the standard speed of 1,500 r.p.m. can be retained.

It has been found that the best compromise on intercooler design is a simple coiled pipe which is capable of accommodating varying expansions without imposing undesirable loads on either the cooler or cylinder. Another advantage is that employment of the cooler permits the compressor to be boosted from the cabin-pressurization supply, such an added constant output being of particular use for serving windscreen wipers and automatic controls.

In the new S50U compressor the master relief valve has been incorporated in the delivery-valve assembly so that a beneficial weight-saving can be made in pipe joints and mounting. In addition, a magnesium crankcase of a more rigid design has been adopted.

Current development work by the company is devoted to a three-stage compressor based on the S50U design, intended for a generating capacity of 3,000 lb/sq in. Data have been gained leading to the design of a larger unit intended for aircraft installation, and work on these prototypes has shown that 3,000 lb/sq in can well be adopted for ram operating pressures.



PROGRESS IN TURKEY

National Designs Predominant

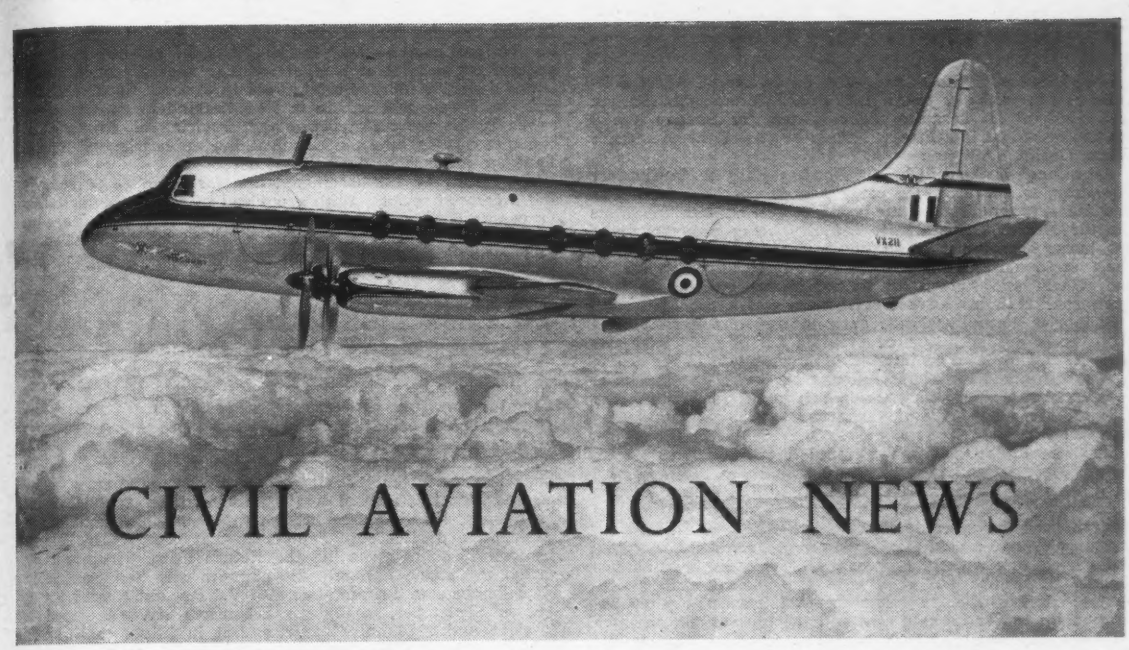
Bearing a strong resemblance to the French S.E.C.A.N. *Courlis*, the T.H.K. 11 pusher is now undergoing flight trials at Ankara.

FOLLOWING an account of the activities of the Turkish Air League's aircraft factory at Ankara, published in *Flight* of March 24th, 1949, recent information indicates that Turkey is now pursuing a policy of concentrating on nationally designed aircraft rather than on one of producing those of German or Russian origin. Prominent among new developments are the T.H.K.14, a side-by-side two-seat primary training glider; the T.H.K.2, a single-seat powered aircraft, fully aerobatic; and a twin-engine light transport, the T.H.K.5A. Dakota conversions for Turkish State Airlines, and approximately 100 Miles Magisters (being built under licence), are also being handled by this factory.

Work is proceeding on two new designs—the T.H.K.12, a 12-passenger feederliner powered by two 600 h.p. Pratt and Whitney R1340 radial engines, and the T.H.K.15, a two-seat tandem all-metal primary trainer bearing a resemblance to the De Havilland Chipmunk; it is hoped to produce the T.H.K.15 in quantity for the Turkish Air Force.

Flight trials are in progress with the T.H.K.13, a flying-wing type of glider intended basically for aerodynamic research A powered version is also projected. A prototype T.H.K.11, almost identical with the French Courlis—a twin-boom four-seat pusher—is now in the flight-testing stage.

Production of engines is being undertaken by a new factory at Ankara and although to date only De Havilland Gipsy Majors have been built under licence, the Turkish Air League is aiming at the eventual large-scale production of nationally designed piston engines and gas turbines. W. G.



CIVIL AVIATION NEWS

PLACE IN THE SUN: Clear of a dense cloud bank, the prototype Viscount (which is now in possession of a Normal Category C. of A.), ascends to its cruising level. News of recent developments in connection with this notable turboprop airliner appears on pages 447-449.

REACTION

SUFFICIENT time has now elapsed since the S.B.A.C. Show to allow a fair assessment of world (and particularly) American reaction to the British industry's timely presentation of its well-developed gas-turbine airliners.

Some of the trans-Atlantic admissions are illuminating, if only because they *are* admissions; it would seem that a search for excuses appeared too formidable a task. Leading American aviation journals are brutally frank about what *Aviation Week* calls "the three-year lead which the British have gained while we have marked time to ponder the economic efficiency of jets, and which may lose for America her predominance in civil air transport." Senator Edwin Johnson, of the Interstate and Foreign Commerce Committee is reported by the same journal to have been informed that several U.S. airline presidents have arranged to purchase British jet aircraft during the next three years. A timely coincidence was last week's announcement (enlarged upon on pp. 445 *et seq.*) of a C. of A. for the Vickers Viscount, followed by news of the devaluation of the pound sterling. This conjunction should increase considerably the Viscount's chances on the American market, where airline operators are faced with the increasingly urgent problem of replacing their ageing DC-3s and DC-4s.

Another prominent weekly, *American Aviation*, would appear to be attempting to hide its own misgivings under a mantle of criticism of the British method of aircraft procurement, which, it claims, "possesses neither virility nor the discipline of state control." Our industry is accused of being slow and old-fashioned, of failing to anticipate useful designs and adopt modern ideas and, above all, to be lacking in efficient civil power units. Though there may be a grain of truth in accusations of our having, like the French, too many prototypes and not enough established types in full production, the general theme of the argument strikes a very odd note in the face of recent developments. Apart from pure-jet progress, of course, there are the encouraging possibilities of prolonging the life of the DC-3 by the installation of Mamba turboprops—a life over which the 1952 I.C.A.O. requirements are casting the shadow of obsolescence. Mention of the recently extended overhaul period of the Bristol Hercules to 700 hours, and the excellent service it is giving in the Vikings, would also appear to confound the accuracy of the same critic's accusation that Britain is lacking efficient civil power plants.

Our contributor "Favonius" in this week's "American Notebook" (pp. 436-439) quotes Mr. W. E. Beall, Boeing's vice-president of engineering and sales, as having said: "As things stand at the moment, it may well be that the U.S.A. will lose not only world markets to the British jets, but, because of competition, may be forced into buying British for lack of such types in our own country."

Such comments, and others that have been made, give some measure of the sensation—the term is not too strong—which Farnborough's revelations have caused across the Atlantic. More than once during the past week we have heard the view expressed that British aircraft manufacturers would be well advised to follow up their advantage by catering specifically for potential American markets in their immediate design and production plans. Certainly it seems that we have, by our "slow and old-fashioned methods," stumbled upon a possible means of winning some much-needed dollars.

TRANSATLANTIC FARES

AS a result of the sterling devaluation, airline fares for transatlantic travel from Britain are to be increased by 44 per cent with effect from October 1st, but those to Continental and other non-dollar destinations will not be affected. This will mean an increase of £38 8s in the single fare from Britain to the U.S.A. Fares to South America are affected in that the portion from Dakar to Rio de Janeiro will be adjusted to correspond to the decreased value of the pound.

Sir William Hildred, director-general of I.A.T.A., disclosed on September 22nd that this decision was taken at an emergency meeting by representatives of 32 countries, but said also that the situation will be subject to review at the next meeting of I.A.T.A. at Mexico City in November. Both Switzerland and Czechoslovakia have reserved their decisions for further investigation. American companies operating point-to-point routes in non-dollar areas are likely to suffer a considerable loss of revenue in the interim period until a new policy is adopted.

AERODROME OWNERS ASSOCIATE

MORE than fifty members and guests of the Aerodrome Owners' Association last week travelled to Manchester for the Association's second post-war summer conference.

The proceedings were opened formally at Ringway Airport on September 21st by the Lord Mayor of Manchester, Alderman Robert Moss, J.P., and his remarks on the air-mindedness of Mancunians were given emphasis shortly afterwards by the announcement of a new £1,000,000 development plan for Ringway. The present 06-24 main runway is to be strengthened and lengthened to nearly 2,000 yards to cater for the new generation of airliners now envisaged for B.E.A. and other European lines, and a new S.E.-N.W. runway is to be built to supersede the present 02-20 and 10-28 ones. In addition, the parking apron is to be greatly extended. These improvements, together with the attractive new passenger buildings, should make Ringway one of the finest provincial airports in Europe.

The tour of the airport which followed included a visit to

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the flight sheds of the Fairey Aviation Company, where delegates saw servicing of ex-Air Lift R.A.F. Yorks, modification and overhaul of Mosquito night fighters for Sweden and a routine test-flight in a Firefly Trainer by one of the company's pilots, Geoffrey Alington.

After lunch in the drill hall of No. 613 (City of Manchester) Squadron, R.Aux.A.F., the party went to the Avro factory at Woodford, where Tudors are being converted into freighters for the British Corporations, Lincolns being brought up to the latest operational standard for Bomber Command, and the ever-popular Ansons still coming off the assembly line for the R.A.F. and foreign air forces, having outlived in production all their more spectacular successors.

A tour of carefully chosen parts of the Avro experimental shops gave an indication of progress being made with the Athena, and revealed an interesting development in the design of Coastal Command's new Shackleton patrol-bomber—not, however, connected with a remark by one member that he did not see why "Postal Command" wanted such a big aircraft!

The second day of the conference opened with a talk on "Fire Fighting and Rescue Organization for Aerodromes" by J. A. W. Brooker, M.B.E., Deputy Chief Fire Service Officer at M.C.A., followed by practical demonstrations of modern fire-fighting equipment. A highlight was the firing of a huge, petrol-soaked pile of old aircraft components, tyres, and barrels of magnesium trimmings. This display unintentionally underlined the vital need for efficient airfield fire-fighting services when the pumping mechanism of the demonstration fire-tender broke down, and the fire began to assume colossal proportions. Fortunately, prompt action by the Ringway Airport Brigade, which was standing by, soon got it under control beneath mountains of foam.

Finally, a paper on the present and possible future development of helicoptors was read by R. H. Whitby, assistant to the Controller of Research and Special Development, B.E.A. He left the Association's members with the impression that one of these days they might fly to a future summer conference by helicopter—if there are any non-Civil Service aerodrome owners left by that time.

SOLENT IV FOR T.E.A.

THE first of the four Solent IV flying boats ordered by Tasman Empire Airways to replace Sandringhams on the Auckland-Sydney route left Southampton for Auckland last Thursday, September 22nd. Among those on board was Capt. J. K. G. Bartlett (Bristol's sales director), who took with him a film recording the history of the Brabazon (a Crown Film Unit production, it is to be screened in New Zealand simultaneously with its first London showing early in October).

The aircraft was flown by a Tasman Empire Airways crew comprising Capt. C. Griffiths (pilot), 1st Off. F. Kilgaur, Snr. Eng. Off. D. R. Phillips, Radio Off. D. Reid, and Snr. Flt. Steward R. Chidwick, together with Capt. J. Grunett (B.O.A.C.). Also on board were Capt. A. Brownjohn (T.E.A. operations manager); Mr. Nick Higgs (Short Bros. and Bristol agent in New Zealand), who negotiated the contract; and Mr. W. R. Farnes (sales manager, B.A.C. Aircraft Division).

Before leaving, Capt. Griffiths, Capt. Brownjohn, Capt. Bartlett and Mr. Higgs recorded interviews for the B.B.C. Capt. Brownjohn mentioned the climatic difficulties of the Tasman crossing and stressed the suitability of flying-boats for this particular route. He said that the Solents would be undertaking a total of twelve crossings weekly, which represented a weekly mileage total of about 30,000. Capt. Bartlett and Mr. Farnes will remain in New Zealand for two or three weeks to discuss maintenance and servicing of the Solents' Hercules 733 engines and, incidentally, application of Bristol Type 170 aircraft for agricultural purposes.

The Solent IV has accommodation for 30 to 44 passengers and a crew of seven. With a payload of 17,124 lb, including 44 passengers, luggage, mail and freight, it has a range of 1,450 miles, cruising at 200 m.p.h. at 10,000ft. With payload reduced to 8,759 lb, and including 40 passengers, the aircraft's range is extended to 3,000 miles.

B.O.A.C.'S LIBERATORS

AFTER eight years' service between the U.K. and Canada, B.O.A.C.'s five Liberators, operated by Scottish Aviation crews, are being withdrawn. These aircraft and one other Liberator now out of service have made more than 3,000 crossings of the Atlantic and have flown more than 10,000,000 service miles.

Their Atlantic history began in the summer of 1941, when they were converted for winter operations; carburettor heating was installed, alcohol sprays were fitted to clear ice from the intakes, shutters were fitted to the oil coolers and cabin heating was devised. In September that year B.O.A.C. put the aircraft on to operating the Return Ferry Service; they carried to Canada not only the aircrews who had previously flown bombers to Britain, but also V.I.P.s and freight.

Since September, 1946, the Liberators have operated a "freight and mail only" service, but in future their loads will be carried by the Constellations which have operated the U.K.-Canada passenger service since 1947 and more of which will become available for use on that route when B.O.A.C.'s Stratocruisers are introduced.

COSTLY EXPERIMENT

AFTER six months' experimental operation, the B.E.A. service connecting north and south Wales is to close on Saturday, October 1st. In five months only 603 passengers were carried in the Rapides flying from Cardiff to Hawarden (Liverpool) and Anglesey; the total revenue was £1,740. It is understood that the cost of maintaining the services was £9,755, resulting in a loss of £8,015.

Since summer operation has received such poor support, the anticipation of great loss during winter operation has influenced the Corporation in its decision, though it has been said that some kind of service connecting north and south Wales by air may be started next spring.

It will be remembered that the route was opened by B.E.A. in April at the request of Lord Pakenham, against the advice of B.E.A., who calculated that even if the Rapides were always filled to capacity the route would be uneconomical to operate. It was shortly after this that Mr. D'Erlanger resigned from the chairmanship of the Corporation.

VISCOUNT'S FUTURE

FOLLOWING the announcement that the Viscount prototype had been granted a British Normal Category C. of A., as reported in last week's issue, an opportunity was afforded

NEW ZEALAND BOUND: R.M.A. *Ararangi*, the first of the Solent flying-boats to be delivered to Tasman Empire Airways, taking off from Southampton for Auckland on September 22nd. Four of these flying-boats will operate between Auckland and Sydney, carrying up to 44 passengers on each flight.

to *Flight* for discussing this, and other Viscount developments, with Sir Hew Kilner, Deputy Chairman of Vickers-Armstrongs, and Mr George Edwards, Chief Designer. Sir Hew spoke warmly of the helpfulness and co-operation of the A.R.B. In view of the Viscount's novel power plant, he said, a degree of diffidence might have been understandable, but everything possible was done to expedite the tests, and without reference to official working hours.

The C. of A., it should be borne in mind, applies to the prototype, and not to the "700" production model; it does not allow the use of the pressurizing system, nor does it cover operation in icing conditions, and a period of regular usage on an airline is mandatory before the Viscount is cleared for unrestricted service. De-icing and pressurizing tests will be in progress during the winter, and in this connection it is learned that Rolls-Royce have already bench-tested a Dart with a spray ring to simulate the most severe icing conditions. Results were extremely satisfactory.

Concerning the opposite end of the temperature scale, Mr. Edwards made some encouraging observations on the subject of water-methanol injection which, on high-altitude tropical airfields, will restore the full I.C.A.N. rating of the Dart. Appreciations have been made covering the operation of the Viscount from Bogota and Mexico City—among the most difficult airfields in the world in respect of take-off—and a far better payload is indicated than is possible with conventional piston-engined aircraft

The latest particulars issued relative to the production Viscount 700, with four Rolls-Royce Dart RDa3 turboprops (1,400 s.h.p. plus 355 lb residual thrust) are: Span, 94ft; wing area, 963 sq ft; all-up weight, 50,000 lb; wing loading, 51.9 lb/sq ft; max. landing weight, 47,500 lb; fuel tankage, 1,800 gal; cruising speed at mean weight of 43,000 lb on 70 per cent power, 316 m.p.h. at 25,000ft; m.p.g. under the foregoing conditions, 1.32; passengers (normal), 40; passengers (high density), 53.

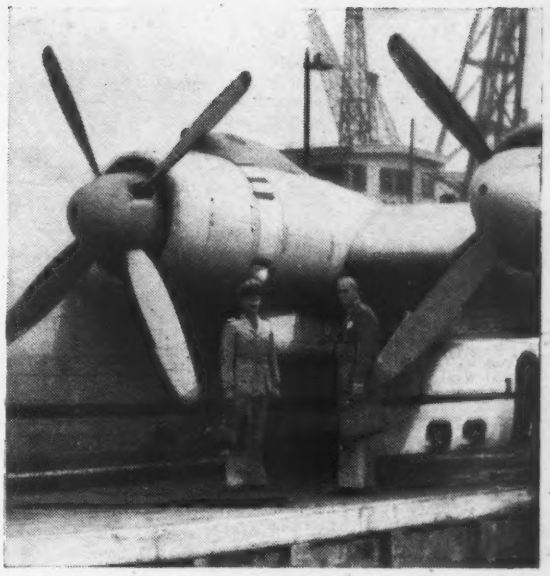
With the increased tankage the maximum stage length, with a 4,000-lb payload, is 1,800 miles—this with reserves for 230 miles to an alternative airport and a 45 min stand-off at 5,000ft (pure-jet protagonists please note!). With the same reserves the normal complement of 40 passengers, with 46 lb of baggage each, can be carried for 1,000 miles. The provision of extra tankage is one result of Mr. George Edwards' visit to the U.S.A. during the early summer and his study of American requirements. He points out that the Viscount is no longer a mere DC-3 replacement but, to a large extent, must be considered as a successor to the DC-4.

Of three layouts studied by Vickers-Armstrongs, that designated "40C" is likely to be best received. This provides for 40 seats in pairs, on each side of the gangway, removable or folding tables at all seats, and a window for each two seats. Forward and aft, near the entrance doors, are large freight or luggage compartments, with a total capacity of 427 cu ft, and there is an additional 100 cu ft of stowage space under the floor. The radio operator and his station are dispensed with and the flight crew numbers two in addition to the stewardess, whose galley is situated forward of the passenger saloon, on the port side. The toilet compartment is at the rear, opposite the main entrance door.

Apart from the increase in tankage, one of the most interesting Viscount news items concerns the de-icing system. In order to take full advantage of the low drag of the Dart it has been decided to mount all auxiliary intakes on the inboard units only, thus allowing the closest possible cowling for the outboard pair. The hot-air supply for de-icing is therefore taken only from the inner Darts, but this is claimed to detract in no way from the efficiency of the system, nor from its ability to give fully adequate de-icing from one power unit only.

Anyone who has studied the performance and amenities of the Viscount will understand that it is a costly aircraft; the sterling price, in fact, is £167,000; though this may be decreased if the number constructed exceeds the minimum of 100 now foreseen. Some 40 will be acquired for B.E.A. and B.O.A.C.; Canada and Australia are "very interested" and, as is well known, executives of American operating companies have not stinted their praise. Outside the possible American market, the extent of which is extremely difficult to gauge, 120-200 Viscounts might be absorbed by British and other operators.

By early 1952 production should be well under way, but before that date one or two examples may be operating on a semi-experimental basis; the prototype, in fact, may be seen flying B.E.A. routes some time next year.



Short Solent for Tasman Empire Airways: Capt. Bartlett, of Bristols, with Capt. C. Griffiths (left) on the pontoon at Southampton before embarking. **(See story on p. 444).**

BREVITIES

SIR WILLIAM HILDRED, director-general of I.A.T.A., is to make a three weeks' tour of South America during October for the purpose of meeting airline and government officials.

* * *

It is understood that following B.E.A.'s first profit in July, the profit for that month and August amount to some £120,000. The Corporation carried 103,426 passengers during August of which 39,366 flew on Continental services and 64,060 on internal routes, which latter includes the Channel Islands. The month's figure is understood to show an increase of 22.6 per cent over August, 1948.

* * *

A miniature "air lift" was recently organized to carry ten tons of building material from Ladysmith, Natal, to Mokhotlong, an isolated camp in Basutoland. The only alternative and practicable surface transport to the camp was by pack pony; the load was carried by air in seven round trips.

* * *

On and after October 1st the B.S.A.A. Cargo and Passenger Reception Offices at 9-11, Albemarle Street, London, W.1, will be closed and enquiries for passenger bookings should be made to B.O.A.C., 75, Regent Street, London, W.1 (Victoria 2323); cargo enquiries should be addressed to Airways Terminal, London, S.W.1 (Victoria 2323); and cargo for despatch should be delivered at the B.O.A.C. Cargo Section, Glasgow Terrace, London, S.W.1. Telegrams for Regent Street, Airways Terminal or Glasgow Terrace should be addressed "Speedbird, London." The telegraphic address, "Reserflite," hitherto used for B.S.A.A. at Albemarle Street, should be discontinued.

* * *

Twice-weekly services between San Francisco and Tokyo by Pan American World Airways' Stratocruisers are to start on October 17th. The route will be *via* Honolulu and Midway, with a flight time of 25 hr 50 min—nearly eight hours less than the present 34 hr required for the trip. On the return journey prevailing westerly winds reduce the flying time to 22 hr 45 min. Stratocruisers are also flying on the company's routes to Hawaii, Bermuda and London.

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The introduction of a single airway bill on cargoes carried over the routes of Panagra and Slick Airways is expected to produce substantial increases in cargo shipments between principal cities in the U.S. and the west coast of South America.

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The new bill is expected to facilitate shipments by eliminating much of the duplicated paper work previously necessary. Panagra has a similar agreement with National Airlines for cargos between the west coast of South America and the east coast of North America.

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MacRobertson-Miller Aviation Co., Ltd., plans to open a service between West Australia and Indonesia. Normally the route is flown *via* Darwin, but the company proposes to shorten the journey by 700 miles by flying *via* Derby and Keopang.

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Pan American World Airways are extending their reduced summer fares until the end of November, although tickets must be purchased before November 1st. By an arrangement between P.A.A. and two domestic airlines, the excursion fares operate between the eastern and central United States and tourist resorts in the Caribbean, Central America and Mexico.

* * *

During August the Government-owned Trans-Australia Airlines carried their millionth passenger; they claim this to be a world record for the first three years of any airline's operations. The line recently received a new retrospective airmail contract increasing its annual grant from £324,000 to £400,000 for the year ended June 30th, 1949.

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Prior to a demonstration tour of the United States, a Saab Scandia landed at Hartford on September 8th after a successful flight *via* Scotland, Iceland and Greenland. Designed as a replacement to the DC-3, the Scandia completed a successful demonstration tour of Europe last year. A modified version is at present being planned to suit American requirements; seating capacity is being increased from the present 24-32 to 30-38 and cabin pressurizing installed.

The Board of Central African Airways Corporation has appointed Mr. Robert Gavin McCoy as general manager. Mr. McCoy joined Imperial Airways in 1938, and became technical assistant to the director-general of B.O.A.C. in 1942 and later deputy-manager of No. 1 Division. He went to Africa in 1945 as technical manager and later became B.O.A.C. station manager at Johannesburg.

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Fairflight, Ltd., one of whose directors is A.V-M. D. C. T. Bennett, has reconverted its Tudors for passenger-carrying after service as tankers on the Berlin airlift. The seating layout has been so arranged that only the number of seats required is carried, thus leaving generous space for additional passenger comfort. Two classes of travel are offered—luxury and "airist"—and the cost of chartering is usually of the order of 3d per passenger per statute mile for the luxury class and just under 2d when 72 passengers fly "airist."

* * *

At a meeting of the International Air Transport Association in The Hague on September 16th, Mr. Warren Lee Pierson, president of Trans-World Airlines, was elected president of the Association in succession to Dr. Albert Plesman, of K.L.M. Mr. K. H. Staple, of B.O.A.C., was elected chairman of the Legal Committee. The meeting also accepted an invitation to hold the sixth annual meeting—which is due to commence on September 10th, 1950—in the United States.

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Mr. William Walter Warner, A.F.R.Ae.S., has recently been appointed service manager of Airspeed, Ltd., at Christchurch, and is responsible for the servicing and maintenance of Ambassadors at home and abroad. Apprenticed to the Sopwith Aviation Co. in 1917, he has been concerned with the practical engineering side of Service and civil aviation ever since. During the war he served in the Technical Branch of the R.A.F., afterwards becoming maintenance superintendent of B.S.A.A. and, later, special technical representative for Skyways.

FROM THE CLUBS

A NORTH African "fine wines" rally and air race has been organized by the Aéro-Club d'Oranie and will be held on October 15th to 16th at La Sénia airfield, Oran. The race will consist of 20 laps of 20 km, preceded by an eliminating race, and is limited to aircraft with maximum engine capacity of 8 litres. The first prize is fr. 1,000,000, and in the 7-litre class a first prize of fr. 300,000 is being offered. A rally prize of fr. 300,000 and other awards will also be competed for. Competitors will congregate on October 15th at Sidi-bel-Abbès.

The entry-list closes to-morrow, September 30th, but entries made within the next day or two through the R.Ae.C. are likely to be accepted provided the intending entrant immediately notifies the Aéro-Club d'Oranie by wire; the address is: 14, Avenue Loubet, Oran.

* * *

AT Yeadon Airport during August, the West Riding Aviation Centre completed 36 hours' flying and one student made his first solo. Among recent visitors to the Centre were Mr. Geoffrey de Freitas, the Under-Secretary of State for Air, together with a Dakota-load of ministerial officials, who—as reported in *Flight* at the time—were on a tour of flying clubs. Another visitor was Colonel Beyers of the South African Air Force.

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WHEN Mr. de Freitas visited the recent A.B.A.C. Convention at White Waltham he did not, as reported, arrive in an R.A.F. Anson. Though he left in an Anson he had arrived (like many other visitors) in an aircraft belonging to his own club—in this case a Herts and Essex Auster.

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DURING the coming winter the Surrey Gliding Club is to organize a series of lectures every Saturday evening; these are in addition to a number of social events, which will include the Christmas party, to be held on December 10th. The club now has 37 Silver "C" members, while two Gold "C" height awards were won during the summer. On August 14th "Micky" Gilbert reached 7,000ft and so became the first woman non-power pilot in the club—and possibly in the country—to obtain her Silver "C."

STARTING YOUNG. S/L. E. J. Furlong, D.F.C., introduces a young passenger to the joys of gliding in the two-seater T-21 *Dragonfly*. During the recent National Gliding Contests at Great Hucklow one of his passengers was Lord Pakenham.

During July and August launches numbered 747 and 648 respectively, and the hours flown were 166.39 and 190. On September 10th the usual crowd of enthusiasts was supplemented by visitors from Cambridge and the Anson-Hurry Olympia from Dunstable. A few days later, a welcome visitor was John Leach of Slingsby Sailplanes, who demonstrated the Motor Tutor. A number of members were able to fly it (although the weather that day was uncooperative) and pronounced themselves very impressed.

JET TUNNEL

High-speed Flow at Low Overall Cost

THE wind tunnel was one of the first pieces of aeronautical laboratory apparatus and since its inception has developed along classic lines. That is to say, the initial concept of using a motor driven fan to produce the requisite airflow has remained unchanged until recent years. With the enormous increase in flight speeds which has come about during the past decade, however, the powers required to produce tunnel windspeeds approaching and surpassing that of sound have risen to such tremendous values that the constructional and operating costs of wind tunnels of the traditional type have become prohibitive.

For these reasons, tunnels of intermittent-flow types have been and are being constructed in which air stored at high pressures is released through a working section for a short period (during which the flow velocities can be extremely high) after which the storage chambers must once more be pumped up for the next run. Alternatively, a vacuum chamber can be filled with air *via* a working section to produce similar high-speed flows. Even the smaller tunnels of these types are by no means inexpensive.

Some little time ago, however, a new approach to the high-speed tunnel problem was evolved at the English Electric Co., Ltd., makers of the Canberra. The idea was delightfully simple, in that all that was required to generate the requisite airflow was an ordinary turbojet unit mounted inside a relatively short length of tunnel. A Rolls-Royce Nene with a static thrust of 5,000lb was chosen as the power unit and some idea of the compactness of the installation is given by the fact that the tunnel has been erected in an erstwhile piston-engine test-cell measuring 60 by 34 by 18ft.

In form the tunnel is perfectly straightforward. The Nene is housed in a nacelle which in turn is housed inside a bulged portion of the tunnel downstream of the working section. The principle of operation is that flow through the working section is induced by the ejector action of the jet efflux, so that in this sense, the Nene can be regarded simply as an extremely powerful ejector pump.

Air enters the tunnel from a settling chamber *via* a gauze filter, thence flowing through an intake flare to the 3ft 8in by 1ft working section. It is then diffused down to the "pumping section" where one-third of the flow is passed through the jet unit, the remaining two-thirds flowing outside the Nene nacelle in the annular space between the nacelle and the bulged wall.

A flow velocity of Mach 0.9 is reached with the tunnel empty, and with a model wing of 15in chord, this speed falls only to M 0.83, the corresponding Reynolds number being 5×10^6. On most normal days of the year, operation of a straight-through tunnel of this type would induce condensation troubles if means were not taken to lower humidity at the intake. This trouble is avoided by collecting a proportion of the hot exhaust gases and conducting it forward to mix with the entering air.

NEW BASIC TRAINER PLANS

TWO contracts have been awarded by the Ministry of Supply for the building of prototypes of a new basic trainer for the R.A.F. Handley Page (Reading), Ltd., announce that they, as one of the companies concerned, have designed a low-wing, side-by-side machine known as the H.P.R.2 to meet Service requirements. It is destined for duty anywhere in the world and, with the power of one Armstrong Siddeley Cheetah 17, will be capable of a good take-off and climb performance. It will also have the requisite low stalling speed. The Cheetah 17 gives 420 h.p. for take-off and 280 h.p. for w.m. cruising. Tail-down fixed landing-gear is specified.

All-metal construction is to be employed, and the accent in design has been upon rapid and simple production (using "split construction" methods), interchangeability and easy maintenance.

Percival Aircraft, Ltd., is the other company to receive a contract for two prototypes to the new specification. These trainers are unlikely to go into production until the autumn of 1951.

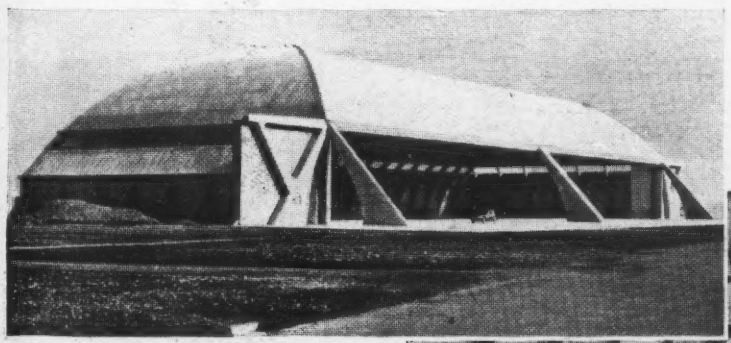
PRESSURE REGULATOR VALVE

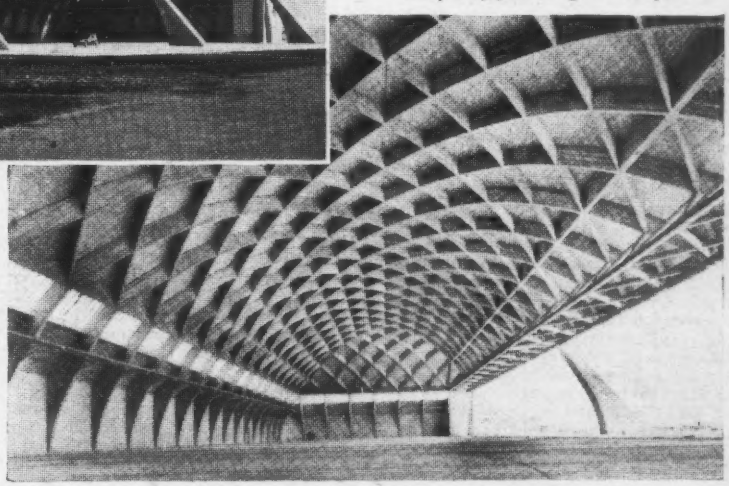
A REDESIGNED pressure regulator valve is announced by Lear Incorporated, Romec Division, Elyria, Ohio. The valve, which can be operated at altitudes up to 40,000ft, reduces pressures up to 100 lb/sq in to any constant lower pressure. Changeable conditions on either side of the valve can be accommodated, and compensation is made for variations in liquid-fuel or water consumption by holding the outlet pressure within narrow limits.

For aircraft application, the unit is designed as a balanced valve with turbo-supercharger connection, by means of which valve pressure is balanced with the air induction system of the engine.

MODERNITY IN HANGARS

Italian Designs with "Self-supporting" Roofs

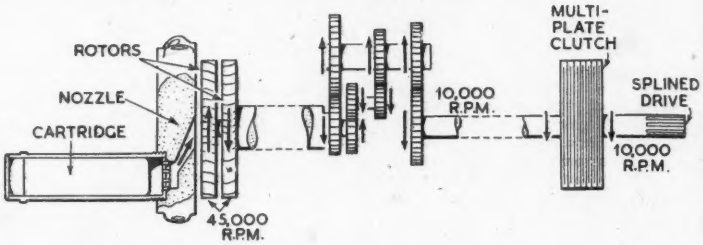




A RECENT issue of *The Architect and Building News* contains pictures of two extremely impressive hangars erected near Rome. The roof of the first (illustrated here) is cast in reinforced concrete sections and is a Lamella-type structure supported by regularly spaced buttresses. In the second hangar—of more advanced design—six buttresses support a 336ft x 120ft roof. The designer, P. L. Nervi, would appear to have produced a structure which fills the need for unrestricted floor space in hangars of such dimensions, though there may be some doubt as to whether the cost of such a hangar would compare favourably with that of the orthodox type of building favoured in this country.

GAS-TURBINE STARTING

—By Turbine : New Plessey Cartridge Starter



Diagrammatic layout of the new Plessey cartridge-operated turbine-starter

THE evolution of the gas turbine has brought with it the necessity for parallel development of accessories, some of them being suitably modified versions of piston-engine equipment and others being entirely new in conception. In almost every case the performance-requirements are stringent. In the matter of starting, for instance, the turbine may require some ten time the energy input necessary for a piston engine of comparable power. In conjunction with the necessity for low weight, this requirement indicates use of a starter with a longer working period than that possessed by the orthodox piston-type cartridge starter, and with a high power output to spin the gas turbine to its starting speed in an acceptably short period.

With their experience of cordite as a source of starter-power, it is natural that the Plessey Co., Ltd., of Ilford, Essex, should incline towards its use, and their development of this principle, the turbine starter type T.S.C. 50, is itself a miniature high-speed turbine. Designed to give approximately ten times the output of the L-type Plessey starter, the turbine starter burns fifteen times the cordite content of the standard L-type cartridge over a working time of 2 sec.

The charge is contained in two percussion-cap cartridges which are fired simultaneously through two nozzles at diametrically opposite sides of a 5in-diameter rotor. The magazine carries six cartridge barrels radially disposed, this arrangement making for compactness with maximum thermal efficiency and balanced loading.

To reduce weight and overheating to a minimum, and in view of the extremely high velocities resulting from the use of the heavy cordite charge, a high-efficiency contra-rotating turbine-wheel system without the interposition of stator blades was designed to give maximum relative blade velocity; a useful energy output is obtained from the second-stage wheel. The drive from the rotors is taken through a triple combining and speed-reducing gear train to the output shaft, which is provided with a splined end dimensioned to S.B.A.C. Standard RS. No. 302.

Peak speed of the shaft is 10,000 r.p.m., corresponding starter-rotor speed being 45,000 r.p.m. A clutch is built into the drive to absorb peak loads during engagement, while to render the starter safe in the event of failure of any part of the drive, an overspeed device limits rotor speed.

Lubrication of the bearings and gear trains is by a built-in pump which, at each start, meters the necessary small amount of oil from the parent power unit.

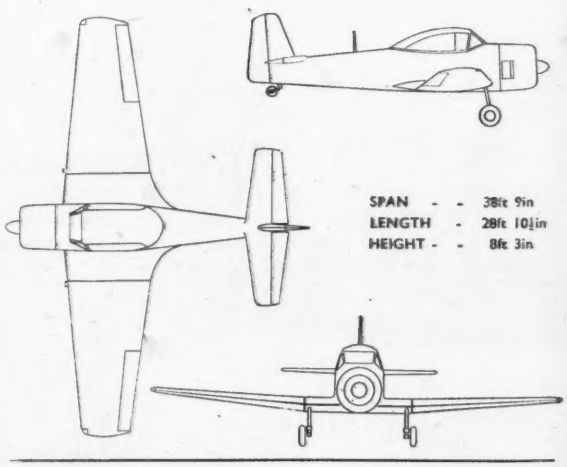
Flying weight of the starter, complete with cartridges, is 50 lb. Maximum energy output over its working period is stated to be 50,000 ft/lb.

AUSTRALIA'S NEW TRAINER

Commonwealth CA-22 Ordered by R.A.A.F.

BRIEFLY referred to in these columns on August 18th, the CA-22 three-seat basic trainer is the first post-war project of the Commonwealth Aircraft Corporation and has been ordered by the Royal Australian Air Force, to whose specification it was designed. Two prototypes are now under construction. A low-wing cabin monoplane of orthodox design, the CA-22 is powered by a 445 h.p. Pratt and Whitney Wasp Junior nine-cylinder radial.

Light alloy is extensively used in the all-metal semi-monocoque structure, only the control surfaces being fabric-covered. Instructor and pupil occupy side-by-side seats and there is a third place behind them for an additional student, while in a slightly modified layout a baggage compartment could be removed to make room for a fourth. Following current British practice the new trainer has a fixed tailwheel undercarriage.



Fixed Undercarriage

The CA-22 wing consists of the usual centre-section, carrying the main-undercarriage oleo legs, and two outer panels; provision has been made for subsequent installation of a retractable undercarriage should it be required. Split flaps are fitted to the centre section and full trailing-edge flaps to the outer wing panels; actuation is electrical.

Of conventional monocoque construction, the fuselage incorporates a crash pylon. A jettisonable sliding canopy to the cockpit is fitted with amber panels and side screens, for simulation of night-flying conditions. Instruments and controls installed on the port side of the cabin closely follow those of the contemporary single-seat fighter. One-piece control columns and swinging rudder pedals operate their respective controls through combinations of rods and cables; a control lock is fitted to the central console. Seats are fully-adjustable, forward-rising, and spring-balanced; they are provided with Q-type harness anchored to the crash-pylon.

The P. and W. Wasp Junior is arranged as a self-contained power plant. attached to the fuselage bulkhead by four bolts, and it has an "orange-peel" cowling arranged to hinge outward in four sections—a unique feature in a single-engined aircraft. Fuel is carried in a 65-gallon main tank within the wing centre-section; an auxiliary belly tank can also be fitted, fuel being transferred as required to the main tank through an automatically actuated cock. The oil tank, included as part of the power plant, has a capacity of 10 gallons.

Brief data for the CA-22 are as follows: span, 38ft 9in; length, 28ft 10½in; height, 8ft 3in; all-up weight, 3,660lb; wing loading, 14.7lb sq ft. Details of performance are not yet available.

CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

BARD OF AVON?

I HAVE found in Shakespeare (*The Tempest*, Act V, Scene I) what I think must be the first poetical description of a jet:—

ARIEL: I drink the air before me, and return
Or e'er your pulse twice beat.

D. HONDROS,
President, R.Ae.C. of Greece.

Athens.

COMPARATIVE RISK

ONE would be interested to know if Mr. Satchler (*Flight* Correspondence, September 22nd), can produce the actual statistics which, he alleges, show there to be no great difference between the risks arising from air and rail travel respectively.

Life-insurance actuaries have considered this matter carefully and would, no doubt, be interested to see any figures that would alter their conclusions. STATISTICIAN.

Pinner, Middlesex.

EXHAUST REHEAT

IN Part II of the very interesting article on "Exhaust Reheat for Turbojets" (*Flight*, September 15th) Table 2 is, in my opinion, slightly misleading. The equipped unit is quoted as having a loss in thrust of 2.3 per cent, but the reheated unit thrust increase is given in terms of this low performance. From the aircraft designer's point of view it would be preferable to give thrust increase over the standard unit. This also affects the reheat fuel consumption which, with the maximum reheat, would be increased to 8.17 lb/hr/lb. There also appear to be some other small arithmetical inconsistencies in the table.

Wescott, Bucks. A. D. BAXTER,
Superintendent,
R.A.E. Rocket Propulsion Dept.

[Admitting that the table may have appeared confusing, the author of the article says that the loss due to the reheat installation was based on the initial standard engine performance of 1,910 lb thrust. All other performance figures were based on an average engine performance of 1,860 lb thrust taken throughout the reheat tests. It is the accepted practice, he states, to base all reheat values on standard engine performance.—ED.]

NOT-SO-SWEET MUSIC

I NOTE that the worthy Sir Alan Herbert, M.P., has been conducting an intensive war, in *The Times* and elsewhere, against the London Airport Traffic which shatters the sylvan peace of his riverside retreat at Hammersmith. So far (unless I have missed some of the correspondence) "A. P." seems to have been winning hands down, for I have seen no really convincing arguments for the other side—though I did rather like the dry comment of a *News Chronicle* reader, to the effect that "it is an established fact that to disembark passengers a modern aircraft must approach the ground sufficiently closely to enable those passengers to step down without injury."

Seriously, however, one feels that Sir Alan's little offensive is not altogether unreasonable. I, too, live on a London Airport departure lane and, although some six miles distant as the Constellation flies, I fully sympathize with people who find the noise trying. Though one of those to whom any well-tuned i.c. engine is sweet music, even I am apt to take a dim view of a York (four Merlins) clambering over my roof-top on full boost at 4 a.m. on a Sunday. This particular service either wakes me completely or so weaves itself into my fevered dreams that I find myself being chased unclothed across an airfield by four Spitfires piloted by Russians and carrying green-and-yellow striped atom bombs slung beneath their wing-tips. (This—the dream, I mean—actually happened, so that my anguished cries for help woke my wife; domestic recriminations lasted for the rest of the day.)

Joking apart, Mr. Editor, one cannot help feeling that, taking the long-term view, it would be greatly to the advantage of civil aviation in general if designers began to take the question of aircraft silencing seriously—and by this I do not mean silencing from the passengers' point of view, but from that of the less fortunate earthbound mortals. I am no technician, and it would interest me to know just what, if anything, can be done to silence exhaust noise without loss of engine efficiency. Can the slide-rule wielders among your readers express a helpful opinion? And, even if exhausts can be silenced to some degree, can anything be done about airscrew noise?

On top of all this, of course, comes the thought that the whole picture may soon be changed by the advent of the jet airliner. Judging by Farnborough, from which my ears still throb, we shall be out of the piston-engined frying pan and into the jet fire. The thought of that 4 a.m. York being replaced by something with four thunderous reheated drain-pipes is a little alarming.

Has anybody a nice little desert island for sale at a reasonable price? HUSH-A-BYE.

Kingston-on-Thames.

FASTER, PLEASE!

I AM in complete accord with your correspondent, Mr. W. Sykes (September 22nd). It would indeed appear to be a reflection on British aircraft manufacturers in general that, in spite of our admitted lead in matters of "hot air propulsion," we never seem to be able to hang on to that coveted prize, the world's air speed record. Could this be purely for reasons of national modesty or (probably nearer the truth) the result of apathy on the part of the M.o.S., the R.A.E., R.Ae.S., the S.B.A.C. or some other of those "initialized" institutions which contrive to uphold the prestige of the British aircraft industry.

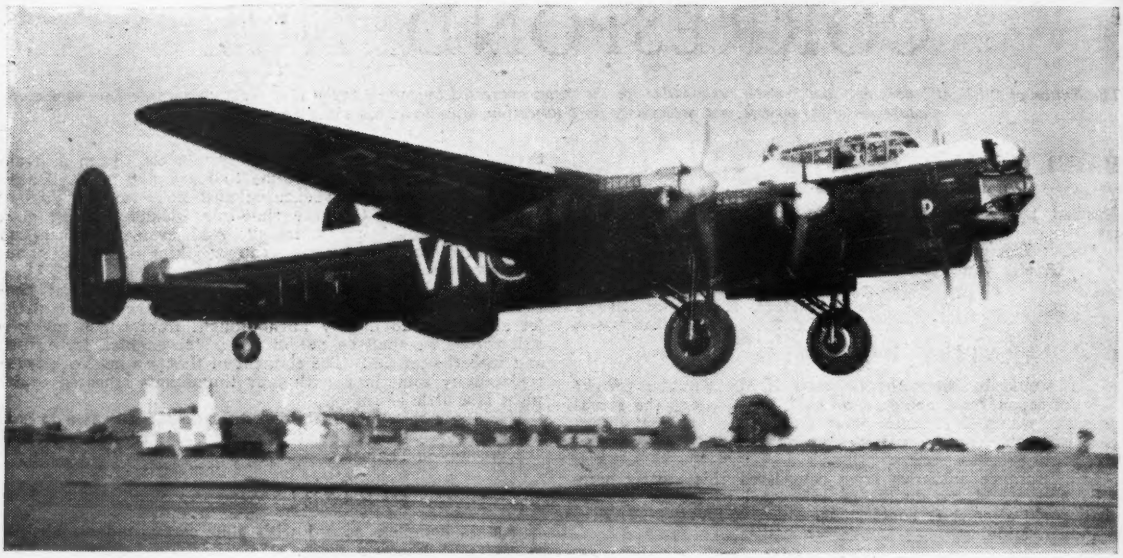
While I agree that breaking air-speed records is far too expensive a pastime for an individual effort, I cannot imagine that any taxpayer would object to contributing towards the cost of a few more gallons of kerosene if (chest puffing with pride), he could see it flashing across the sky in an all-British jet at a higher recorded rate of knots than the aircraft of any other chap—particularly that Uncle Sam fellow across the Atlantic, who always seems to be breaking every world record the very day after someone else establishes it.

Perhaps we could even have a new Society for the British Retention of World Air Speed Records? Think how nice those initials would look, too! I cannot believe that we have no aircraft capable of it, so please let us not linger in an undignified second place for lack of a little "ministerial boost."

London, W.2. POOMIE.

FORTHCOMING EVENTS

Oct.	1.	British Interplanetary Society: Conversazione.
Oct.	5.	R.Ae.S. (Luton): Film Show.
Oct.	6.	R.Ae.S.; "Design Analysis Methods in Research Division of Bureau of Aeronautics, U.S.N. Department," I. Driggs, A.E., F.I.Ae.S., F.R.Ae.S.
Oct.	13.	R.Ae.S. Graduates; "The Time Scale in Aeronautical Engineering," Sir John S. Buchanan.
Oct.	14.	Colleges of Automobile and Aeronautical Engineering; Dance.
Oct.	18.	R.Ae.S. Section Lecture: "Flutter Problems," E. G. Broadbent, M.A., F.R.Ae.S.
Oct.	19.	R.Ae.S. (Reading): "Atomic Energy," A. G. Salmon, B.Sc., A.Inst.P.
Oct.	19.	R.Ae.S. (Weybridge): "Aircraft in Future Warfare," Air Marshal Sir Robert Saundby, K.B.E., C.B., M.C., D.F.C., A.F.C.
Oct.	25th.	R.Ae.S. Section Lecture; "New Methods of Stressing," J. Hadji-Argyris, A.F.R.Ae.S.
Oct.	27.	R.Ae.S. Graduates; "High-lift Devices," R. R. Duddy, A.F.R.Ae.S.
Oct.	29.	Helicopter Association; "Jet Propulsion of Rotor Blades," A. Stepan, Dipl. Ing.
Nov.	2.	R.Ae.S. (Luton): "Gas Turbine Development."
Nov.	3.	R.Ae.S. Graduates; "Hydraulic Analogy of Compressible Flow," H. Ritter, B.Sc. (Eng.).
Nov.	9.	R.Ae.S. (Weybridge): "The Brabazon I," F. H. Pollicut, F.R.Ae.S.
Nov.	19.	British Interplanetary Society: Symposium, "Medical Problems of Space Travel."
Nov.	23.	R.Ae.S. (Reading): "British Airships," Lord Ventry.
Nov.	23.	R.Ae.S. (Luton): Brains Trust.
Nov.	24	R.Ae.S.; "Aerodynamic Cleanness," E. J. Richards, M.A., F.R.Ae.S. (at Bristol).
Nov.	26.	Helicopter Association; "Aero-elastic problems of Rotary Systems," Prof. A. R. Collar, M.A., D.Sc., F.R.Ae.S.
Nov.	30.	R.Ae.S. (Weybridge): "Radar and Aircraft," B. W. Hodlin, B.Sc.
Dec.	3.	British Interplanetary Society: Film Show.



SUB ROSA : One of a "strong force of Lincolns" leaves an airfield "somewhere in England" to take part in Exercise *Bulldog*.

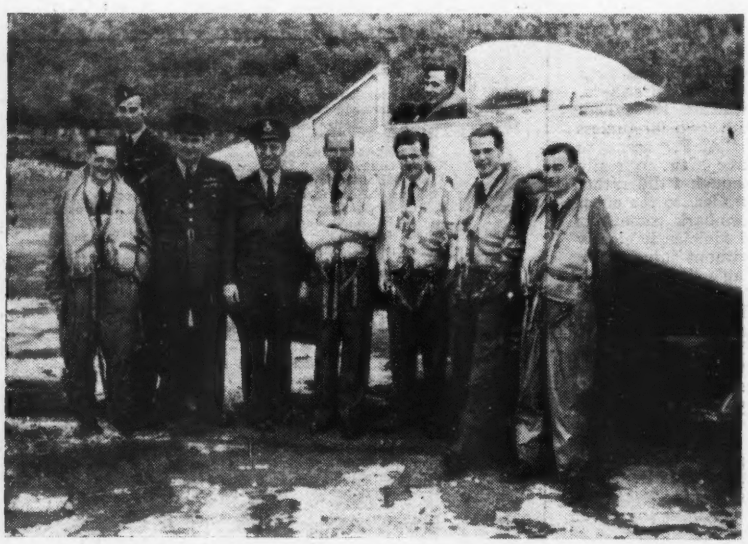
SERVICE AVIATION

Royal Air Force and Naval Aviation News and Announcements

Hastings for Singapore Route

EARLY next month, Handley Page Hastings of Transport Command will go into regular trunk-route service for the first time. Transport Command's heavy commitments on the Berlin Air Lift (in which the Hastings, although not designed for this short-haul operation, have done especially good work) delayed the introduction of the Hastings to the R.A.F.'s overseas services.

Carrying freight and mail, the new transports will be employed on the Singapore route, flying *via* Lyneham, Malta, Fayid, Egypt, Habbaniya, Karachi and Negombo to Tengah (Singapore). The journey will take five days, and there will be 10 Hastings flights per month. Yorks, which have operated R.A.F. scheduled services since the war, will continue to make eight Singapore flights a month in addition to six monthly flights to Nairobi.



WARWICK IN HAMPSHIRE : For Exercise *Bulldog* No. 605 (County of Warwick) Squadron, R.Aux.A.F., were stationed at Thorney Island. Left to right: F/O. G. A. Bolton, F/L. E. H. Pollard, F/L. A. J. Druce, F/O. R. J. Ayling, S/L. J. Timmis, F/O. P. J. Cope, F/O. M. Walton and F/O. D. Monk. In the cockpit is F/O. H. Louden.

Fewer Postings

NATIONAL Servicemen in the R.A.F. will normally be posted only once during their 18 months' service, announces the Air Ministry. The new rule does not apply, however, to those selected for flying training. After an initial period of recruit training, airmen will receive trade training on the stations at which they will remain until release, instead of at schools of technical training. Postings of regular airmen will not be affected by this system.

For Service in Malaya

THE KING has been graciously pleased to approve a number of appointments and awards to members of the Royal Air Force for distinguished service in Malaya between December 1st, 1948, and May 31st, 1949. Aircrew and groundcrew, officers and airmen, are included in the list, which is given below.

At the time of the awards they were stationed variously at Seletar, Sembawang, Advanced Air H.Q., the Singapore Signals Centre, Tengah and Kuala Lumpur; the decorations, therefore, recognize service not only at the front-line bases from which the campaign against Malayan bandits is being waged, but also the establishments which have done invaluable work in supplying, and otherwise supporting, the attacking forces. In addition, 31 officers and airmen have been mentioned in despatches.

O.B.E.

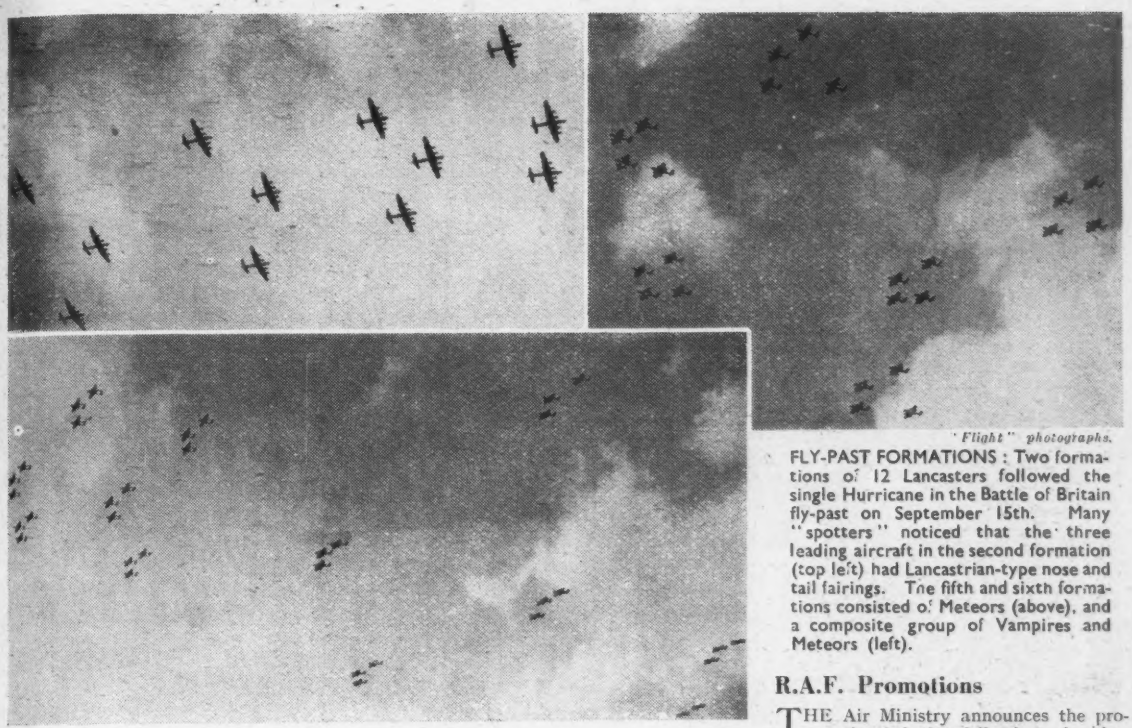
S/L. F. E. McDonnell.

M.B.E.

F/L. A. A. G. Roke, W/O. R. W. Morgan, W/O. B. Smith, W/O. H. F. Walker.

D.F.C.

S/L. J. H. S. Broughton, A.F.C., S/L. J. H. Johnson.



"Flight" photographs.

FLY-PAST FORMATIONS : Two formations of 12 Lancasters followed the single Hurricane in the Battle of Britain fly-past on September 15th. Many "spotters" noticed that the three leading aircraft in the second formation (top left) had Lancastrian-type nose and tail fairings. The fifth and sixth formations consisted of Meteors (above), and a composite group of Vampires and Meteors (left).

SERVICE AVIATION · · ·

B.E.M.

F/S. A. W. Murdoch, F/L. G. E. Roberts, Sgt. R. M. Murray, Sgt. B. D. Potts, Cpl. A. C. Dunglison, Cpl. R. Jacob, Cpl. T. G. Shand, Cpl. E. J. Williams.

N.Z. Assistance

DAKOTAS of the Royal New Zealand Air Force are to supplement R.A.F. squadrons on the supply and passenger route between Singapore and Hong Kong. The first Dakota, piloted by S/L. A. H. Harding, D.F.C., arrived at Changi, Singapore, on September 20th, carrying nine aircrews and six ground staff. They were welcomed by the C.-in-C., Far East Air Force, Air Marshal Sir Hugh Lloyd, and A.V-M. F. J. Mellersh, the A.O.C., Malaya.

Malayan A.T.C.

THE first squadron of a new voluntary youth organization, the Malayan Air Training Corps, has been formed at Singapore. Organized on similar lines to our own A.T.C., the Malayan body is supported by the Governments of Singapore, the Federations of Malaya, and the R.A.F. It is open to youths between 16 and 18 of all communities who are British or Federal citizens. Members will be trained in a range of flying subjects as a preliminary to entering the R.A.F. or civil aviation. Exceptional cadets may be awarded scholarships, presented by local firms and other benefactors, providing flying training up to A Licence standard at the Royal Singapore Flying Club. The first M.A.T.C. squadron, at Singapore, now has 150 members. A second unit will be formed shortly at Kuala Lumpur.

Farming Competition

FOR the second year running, R.A.F. Station Lindholme has won the Air Force competition for unit farms and gardens. The R.A.F. Hospital, Wroughton (third in 1947, fifth last year) came second, and third place went to Cosford (winner in 1947, second last year). Boscombe Down was fourth and Hullavington fifth. All 205 R.A.F. farms and gardens—which total 2,800 acres, and last year produced £141,800 worth of foodstuffs—were considered before the finalists were selected.

R.A.F. Appointments

IN succession to the Rev. W. R. Marsh, K.H.C., who has retired from the R.A.F. after 20 years' service, the Rev. J. R. Appleyard has been appointed Principal United Board Chaplain to the R.A.F. Mr. Appleyard, who is an Honorary Chaplain to The King, has been in the R.A.F. since 1929. For five years before the war he served in the Middle East, and from the beginning of the war until the evacuation he was in France. Since the war he has spent a further two and a half years in the Middle East.

With the acting rank of air commodore, G/C. G. B. Keily, D.F.C., A.F.C., takes up a new appointment as A.O.C., No. 1 Group, Royal Pakistan Air Force, at Karachi. He was, until recently, Senior Air Staff Officer of No. 61 (Eastern Reserve) Group, R.A.F.

G/C. R. C. Dawkins, who has been Superintendent of flying at Boscombe Down for two and a half years, has been appointed Deputy Director of Accident Prevention at the Air Ministry. He succeeds G/C. N. C. Singer, C.B.E., D.S.O., D.F.C., who has retired.

R.A.F. Promotions

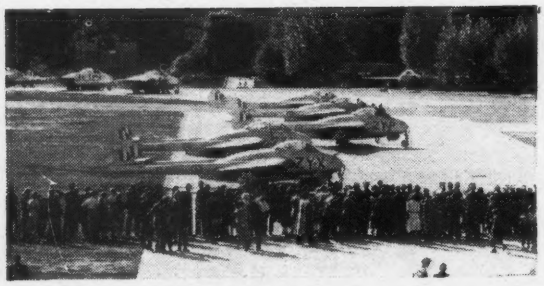
THE Air Ministry announces the promotion of the following air vice-marshals (acting air marshals) to the rank of air marshal: Sir Aubrey B. Ellwood, K.C.B., D.S.C., A.O.C.-in-C., Bomber Command; Sir John W. Jones, K.C.B., C.B.E., A.O.C.-in-C., Technical Training Command; P. C. Livingston, C.B., C.B.E., A.F.C., F.R.C.S., F.R.C.S. (Edin.), L.R.C.P., D.P.H., D.O.M.S., K.H.S., Director-General of R.A.F. Medical Services. The promotions take effect from July 1st, 1949.

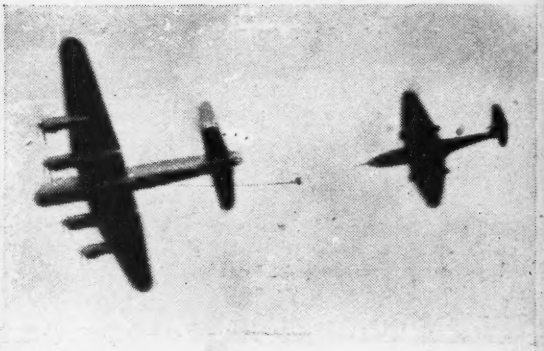
A R.A.F. Record

A DE HAVILLAND Hornet 3 long-range fighter, which had been taking part in Battle of Britain celebrations at Gibraltar, last week flew from the Rock to Bovingdon, Herts, in 2 hr 31 min 36 sec—an average speed of 435.823 m.p.h. It was piloted by G/C. A. C. P. Carver, who commands the Yorkshire Sector of No. 12 Group, Fighter Command, and is the C.O. of R.A.F. Station, Linton-on-Ouse.

G C. Anthony C. P. Carver.

Subject to official confirmation, G/C. Carver's performance will establish a new British national point-to-point record—the fifth to be won by R.A.F. aircrews since 1946. The other point-to-point records are: London-New Zealand in 59 hr 50 min; London-Darwin in 45 hr 35 min; London-Karachi in 19 hr 14 min (all three flights were made in August, 1946, by the Lancaster *Aries*); and, in May, 1947, London-Cape Town in 21 hr 40 min by a Mosquito. The *Aries'* London-Karachi record, incidentally, is in Category 2 (pilot and passengers) and is not affected by Neville Duke's solo re-





BATTLE OF BRITAIN WEEK was notable for the large number of excellent flying displays (watched by 764,000 members of the public) staged by the various stations "at home" on the Saturday. Aerobatic flights of Vampires, shown (top left) at their home base, Odiham, were kept busy touring and demonstrating at several of the stations. The first public exposition of "Meteoric" flight-refuelling (top right) took place at Beaulieu; below it is shown the conclusion of another Odiham item—the Hamilcar "taxying" back to the static park, seen to include a Lincoln, Devon and Prentice. At lower left is A.V.-M. S. F. Vincent, the A.O.C., 11 Group, with his Hurricane—the aircraft which led the fly-past over London. Other aircraft which took part are shown on page 451.

SERVICE AVIATION . . .

cord flight of 15 hr 20 min in a Hawker Fury last May.

G/C. Carver graduated from Cranwell in 1931, and later flew Furies with No. 43 Squadron, Tangmere. He has been intelligence officer at Iraq and Aden, is an R.A.F. Arabic interpreter, and during the war served with No. 107 Squadron at West Raynham. From 1944 to 1945 he was Deputy Director of Air Tactics at the Air Ministry, and was air attaché at Madrid from 1946 to 1947. Before going to Linton-on-Ouse, he commanded R.A.F. Station, Acklington.

N.Z. Squadron Memories

Defence Until Dawn, compiled by F/L. Leslie Hunt.

THE atmosphere of the squadron crew-room, with its pin-up pictures and permanent litter of Mae Wests and scattered escape-kits, is vividly recalled in this intimate story of the brilliant achievements of 488 (New Zealand) Night Fighter Squadron. Former members can live again those glorious days from September, 1942, when the unit first became operational and set out to accumulate its memorable bag of 81 German aircraft destroyed at night. Practically every page contains the combat reports and incidents which were typical of the life of a fighter pilot during the stirring days (or, in this case, nights), of the German air offensive against Britain and later of the Allied invasion of Europe.

The book is published in New Zealand, but copies may be obtained from F/L. Leslie Hunt at 77, Leigham Court Drive, Leigh-on-Sea, Essex; there are only 140 copies of the first edition still available.

Auxiliary Appointment

IN succession to S/L. R. C. T. Goodwin, who has resigned, S/L. John A. Timmis has been appointed to command No. 605 (County of Warwick) Squadron, R.Aux.A.F. S/L. Timmis, who joined the Royal Auxiliary Air Force in 1948, is a former Spitfire pilot, and was a prisoner of war for three years. He joined the R.A.F. in 1940 and was commissioned on completion of his flying training in 1941. No. 605 Squadron, which is based at Honiley, is equipped with Vampire Is.

Reunions

THE third reunion (for all ranks and friends) of No. 644 Squadron, R.A.F., is to be held in London on Saturday, October 1st. Tickets, 5s, from B. R. Tough, 9, The Crescent, Egham, Surrey.

* * *

All ex-A.T.A. members are welcomed to the third reunion of No. 2 Ferry Pool, A.T.A., to be held in Bristol on Saturday, October 29th. Tickets 5s, from Michael Ward, 103, Greenway Road, Taunton, Somerset.

* * *

The G.C.A. annual reunion, for all who were connected with G.C.A. operations, will take place in London on Saturday, November 12th. Details from Miss J. F. M. Cain, 83,Hotham Road, Putney, London, S.W.15.

* * *

The date of the fourth reunion dinner of No. 3 S. of G.R. (Squires Gate), which is to be held at the Casino, Blackpool, is Saturday, October 8th, and not October 29th, as earlier announced in *Flight.* Tickets from A. C. M. Powell, "Monterey," 26th, North Promenade, St. Annes-on-Sea, Lancs.

* * *

A reunion ball for officers who served on the H.Q. staff of No. 11 Group, commanded sectors or stations, or who flew with squadrons in the Group at any time between September 3rd, 1939, and VJ Day, 1945, is being held at the Dorchester Hotel, London, on Friday, October 21st. Air Marshal Sir Hugh Saunders will preside, and it is hoped that Lord Dowding, Sir Keith Park and other distinguished officers associated with the Group will be present.

The ball will begin at 2045 hr and continue until 1300 hr. There will be a buffet supper at 2030 hr and a short cabaret. Tickets, which are limited to 350, are 30s each and are available from the Secretary, No. 11 Group Reunion, Air Ministry, Room 571, Adastral House, Kingsway, London, W.C.2. Applications for tickets should be accompanied by cheque made payable to No. 11 Group Reunion. Dress for the occasion will be mess dress, interim mess dress, evening dress or dinner jacket. Following this first reunion, it is hoped that the 11 Group ball will become an annual event.